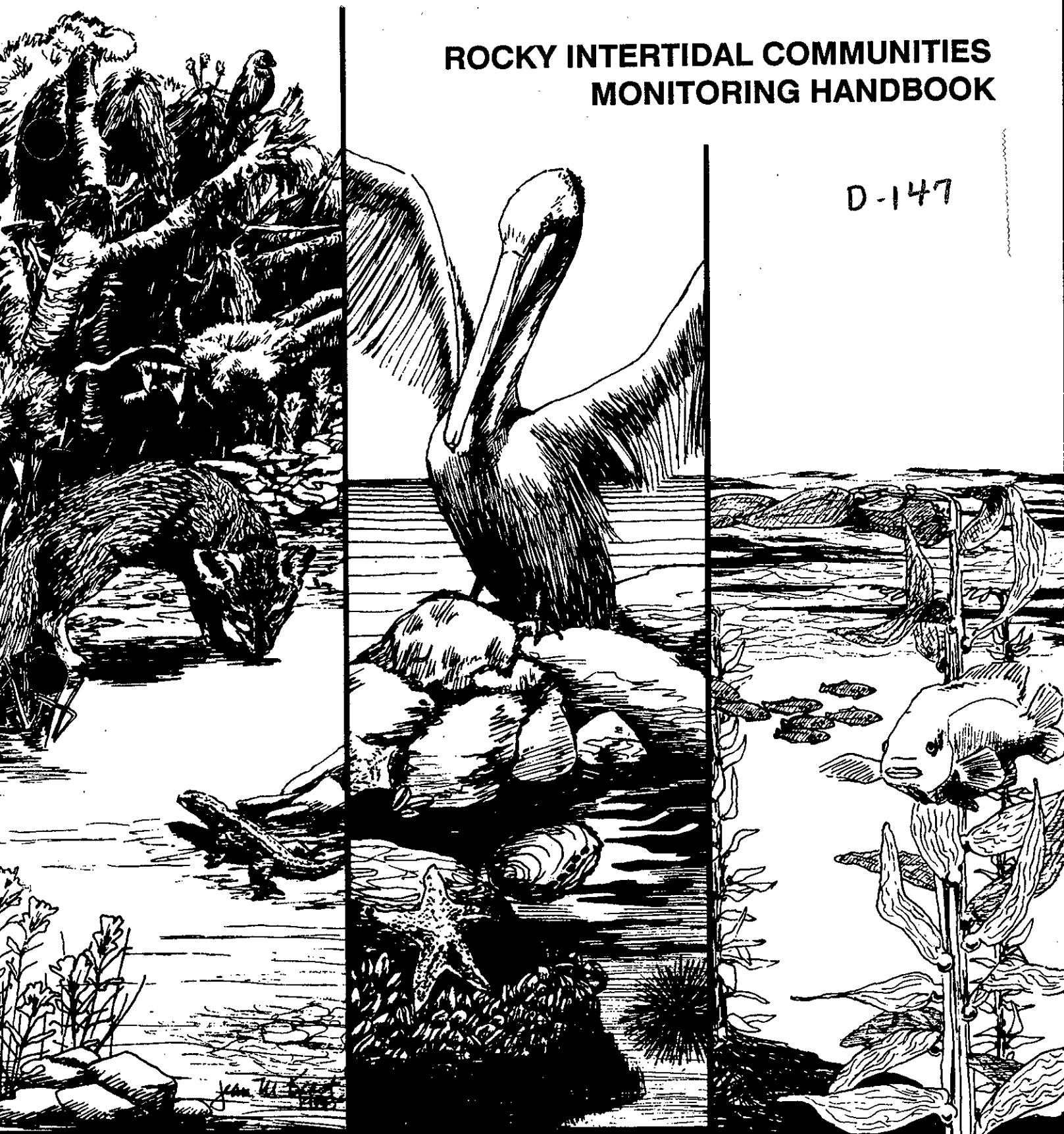
ROCKY INTERTIDAL COMMUNITIES MONITORING HANDBOOK



Channel Islands National Park

National Park Service
U.S. Department of the Interior

ROCKY INTERTIDAL COMMUNITIES MONITORING HANDBOOK

CHANNEL ISLANDS NATIONAL PARK

CALIFORNIA

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ACKNOWLEDGEMENT

The National Park Service wishes to thank the many people who have been instrumental in the development of the rocky intertidal monitoring program. A dedicated cadre of volunteers and biologists of the National Park Service and California Department of Fish and Game conducted the sampling and data collection. Dr. Jack Engle of the Tatman Foundation was especially valuable in site establishment and technique development and refinement through a contract with the National Park Service. VTN Oregon, Inc. established and documented the first monitoring sites on Anacapa Island. California Department of Fish and Game cooperated in sampling and data collection and conducted an abalone tagging study that has increased knowledge of this resource.

INTRODUCTION

Long-term monitoring of the rocky intertidal community is accomplished at Channel Islands National Park by biannual sampling of permanent photoquadrats and black abalone plots. The first rocky intertidal monitoring sites were established on Anacapa Island in 1982 by a consultant to the National Park Service, VTN Oregon, Inc. In 1985, the monitoring program was expanded with the addition of permanent sites on San Miguel and Santa Barbara islands. The purchase of Santa Rosa Island in December of 1986 added a rich and varied intertidal resource to the program. New sites have been added each year bringing the total number of sites monitored in 1988 to 15. Because of the addition of new sites and improved sampling equipment, field techniques, and data management capabilities, this handbook has been completely rewritten since 1984 when VTN Oregon, Inc. developed the original version.

The monitoring program is expected to expand further with the addition of owl limpet and sea star monitoring, the development of a comprehensive species list, and additional black abalone studies.

MONITORING DESIGN CONSIDERATIONS

To monitor seasonal and annual changes in populations of rocky intertidal organisms, 15 monitoring sites representing the range of biogeographical and ecological conditions found in the park have been established on Anacapa, Santa Barbara, San Miguel, and Santa Rosa islands. Site selections were made based upon the following criteria:

- Representative of different aspects of geology, currents, and wave action
- Representative of various levels of visitor use and popularity
- Good access from the island or a protected safe landing nearby if boat access is necessary
- Protected from large waves at low tide
- Relatively level for ease in monitoring the site
- Representative of intertidal resources for that particular island
- Representative coverage of the five tidal zones to be monitored
- Close proximity to kelp forest monitoring sites

Sites were also chosen to coincide with sites used in the Southern California Bight baseline studies conducted by the Bureau of Land Management in the 1970's.

The organisms selected for monitoring represent five tidal zones common throughout the park. These five zones are generally the dominate high and mid-intertidal zones on the islands, although all zones may not be present at each site. The acorn barnacle, *Chthamalus fissus/dalli*, generally dominates the highest zone, where it is commonly found with other barnacles, such as *Balanus glandula* and *Tetraclita rubescens*. A low turf-like red alga *Endocladia muricata* represents the next lowest zone. The rockweed zone is represented by brown algae, primarily *Pelvetia fastigata* and *Hesperophycus harveyanus*. At Santa Barbara Island, the red algae *Gigartina canaliculata* and *Gelidium* sp. are monitored in a zone below the rockweeds. The lowest zone monitored is represented by the California mussel, *Mytilus californianus*. Black abalone, *Haliotis cracherodii*, which support the largest portion of California's abalone fishery, are monitored to evaluate both fishery harvest and environmental conditions. In addition to these index organisms, the abundance of tar (a common occurrence in the Santa Barbara Channel) and bare substratum are monitored at all sites.

MONITORING PROTOCOL

SAMPLING METHODS

Several methods are used to monitor rocky intertidal areas. A random point contact method using photographs (slides) taken of permanent photoquadrats is used to determine percent cover of the dominant organisms in five intertidal zones (described under Photoquadrat Sites). Another method measures movement and abundance of black abalone in permanently established plots (described under Black Abalone Plots). Counts of owl limpets and sea stars have also been initiated (described under Owl Limpet Plots and Sea Star Monitoring).

This section first provides general information that applies to all sampling methods, then describes specific sampling methods and their requirements. Monitoring sites (including how to get to sites and what to monitor) are discussed in the general sampling information section under island site locations.

General Sampling Information

Scheduling

Scheduling for both the establishment of quadrats and monitoring activities is done in January (or as soon as a tide table can be obtained). Check the tide tables for appropriate tides. Low tides of zero or lower are essential for enough working time. Low tides that fall mid-day are the best. Allow enough daylight to work two hours before and after low tide. Plan on sampling one site per day; however, it is possible to sample two sites per day if they have only one set of black abalone plots.

Personnel

A network of volunteers has been established which assists in data collection for both the kelp forest and intertidal monitoring programs. Island staff can also be used when they are available, but it is best not to count on their availability because of other duties. Once the schedule has been established, arrange for volunteers. Teams of four or more (in multiples of two) provide the most flexibility. California Fish and Game biologists have assisted at black abalone tagging sites on San Miguel and Santa Rosa islands which are checked once each year. These biologists can be called upon to assist with monitoring of these tagging sites and potentially sampling of nearby monitoring plots.

Logistics

Transportation. Low tides do not provide much flexibility in scheduling. Therefore, plan trips well in advance and make arrangements for appropriate transportation at the scheduling meeting each month.

Food. The general procedure on overnight trips to the islands is to buy food for the entire crew, using a purchase order in lieu of per diem. A food order is made from a menu and sent to Kathy or Lee at Ven Oak Market in Oak View, 649-1241. They will accept purchase orders and deliver food when needed. As an alternative, participants can all contribute for the food purchase and be reimbursed through per diem or the volunteer account (see the Volunteer Coordinator.) A travel authorization is needed if using per diem.

Island Site Locations

The 15 monitoring sites and a summary of what to do at the sites on each island is described below. Figure 1 indicates the general locations of the sites. More specific maps locating the sites as well as detailed drawings of the photoquadrats and plots are found in Appendix A.

San Miguel Island

The four sites on San Miguel Island are best serviced by land, although on very calm days Harris Point and Cuyler Harbor can be reached by boat. Crook Point can also be reached by boat if there is no south swell; however, there are usually elephant seals on the beach that may be disturbed by a landing craft. Reserve bunk space in advance as limited overnight space is available. For this reason, it is also best to keep the monitoring crew small. For lodging arrangements, Harris Point, Crook Point, and Cuyler Harbor are closest to the ranger station. Otter Harbor is closest to the Point Bennett research station but can also be monitored by personnel staying at the ranger station. Allow approximately two

hours to hike to Otter Harbor from the ranger station. Crook Point is approximately one to one and one half hours hiking time from the ranger station and involves a fairly steep hike. Be aware that Crook Point is the most exposed site when seas are rough. Plan on one day per site plus two days travel to complete San Miguel Island monitoring.

Depending on condition of crew and weather, it is possible to complete photoquadrats at Cuyler Harbor and Harris Point using two people to photograph while the other two people count abalone at Harris Point. It is best to start at Harris Point as sampling Cuyler Harbor on a travel day is possible if flights can be scheduled to allow working time that also coincides with favorable tides. Adverse weather conditions can prevent completing some stations in one day.

Santa Rosa Island

There are currently five sites on Santa Rosa Island. Check with the island rangers about housing at Johnson's Lee or Arlington Camp and available transportation. Johnson's Lee is more convenient when working sites on the south side of the island. Vehicles are needed to traverse the island so check on current policies about off road driving and road conditions which may add time to get to the site. Travel times are slow and two hours or more may be required to drive to a site. Talcott and Fossil Reef sites will require the longest and most arduous hiking. Because of a steep bluff, the Talcott site is accessed via a point of land, approximately 1/4 mile east of the monitoring sites. Fossil Reef requires hiking down the south slope of the island from an accessible bluff. Five days plus travel are required to complete the Santa Rosa Island monitoring.

Anacapa Island

Five different areas are sampled on Anacapa Island. On West Island, photoquadrats at South Frenchy's Cove can be reached at the gap at the east end. Landing is best on the north side on the sand beach. This is where Island Packers Company lands. The photoquadrats and abalone plots at Cat Rock can be reached by hiking from Frenchy's Cove, (a fairly long walk with equipment), or by raft landing on the sand and cobble beach just west of the monitoring site (between Cat Rock and the monitoring site).

Middle Island has three sites that must be reached by small boat. The first photoquadrat site at Middle Anacapa Island West, (formerly MAI Test) is at the landing where the National Park Service sign is located. The second photoquadrat site at Middle Anacapa Island East, (formerly MAI Control) is just to the east of the first site but is inaccessible from the island because of a deep surge channel. An abalone plot site at Harbor Seal Arch is further east and has an easy landing next to the arch onto a sandy-cobble beach between rocky reefs. Beware of occasional waves washing onto this beach.

Because of the proximity of sites, the suggested procedure is to use half the team to shoot both photoquadrat sites on Middle Island one day while the other half counts abalone at Harbor Seal Arch, then work West Island the next day with the same procedure.

Three, one day trips to Anacapa Island are usually required to complete the monitoring. Because Anacapa can be monitored on day trips, it offers a good opportunity for using volunteers from the staff or others who cannot afford much time away.

Santa Barbara Island

Both sites are easily reached by land or by boat. The monitoring can be accomplished by flying to the island and hiking to each site. Or, if lodging on the island is a problem, the work party can utilize one of the NPS boats as transportation to the island and then as a bunkhouse once there. If using a raft, both sites can be photographed in one day, but landing a raft can be dangerous because of the steep reef and occasional large swells. Walking to the sea lion rookery site is not difficult. It is best to follow the trail to the lookout above the sea lion rookery before going down the hill to the intertidal site. The landing cove site is divided, with half the photoquadrats on each side of the dock.

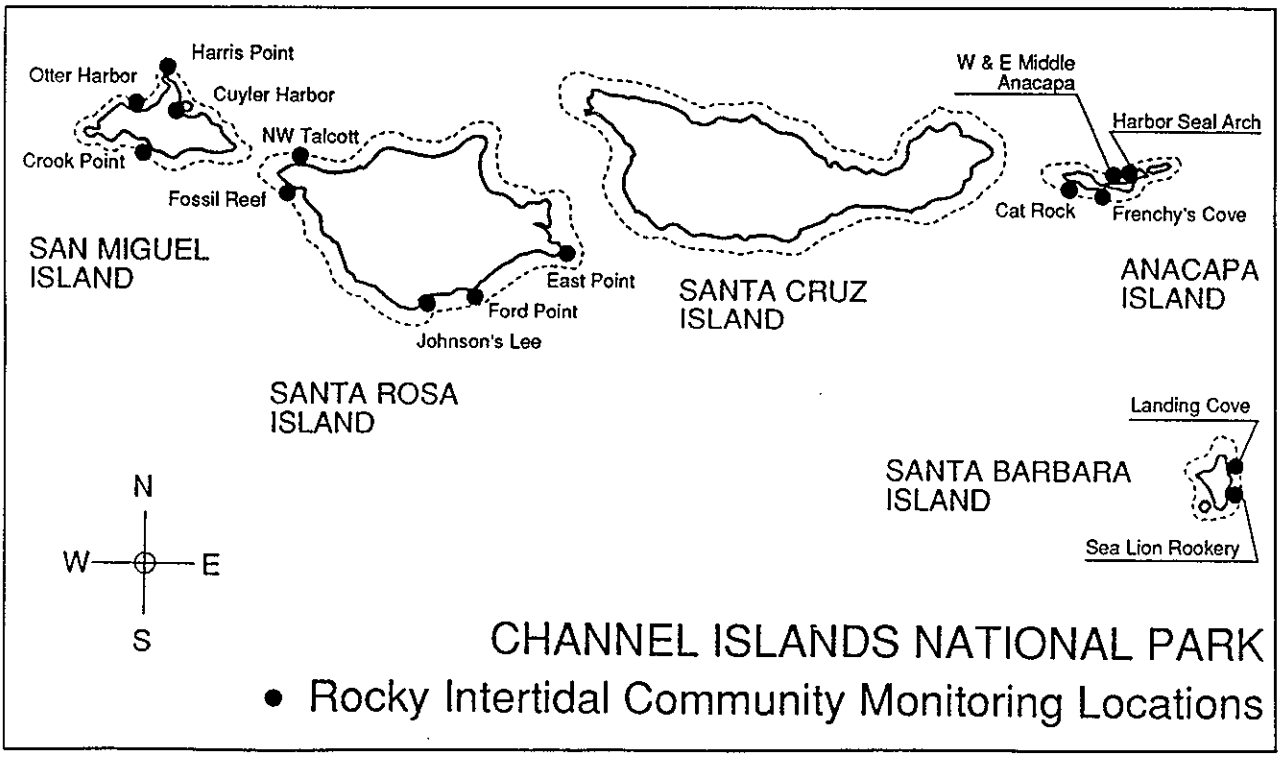
Two work days plus two days travel should be scheduled whether by helicopter or boat.

Table 1. Summary of Monitoring Activities at Each Rocky Intertidal Monitoring Site.

What to do at each Rocky Intertidal Monitoring Site

At all sites-- make a species list; repair epoxy and bolts; record weather and general observations

Island	Site	Photo-quadrat	Abalone Plot	Lottia Plot	Photo Point	Other
San Miguel	Crook Point	20	5	3		observe sea birds, elephant seals
	Cuyler Harbor	20				observe abalone, *Phragmatopoma*
	Harris Point	20	5			observe tar, tagged abalone
	Otter Harbor	20	5	2		count harbor seals, observe elephant seals, tagged abalone
Santa Rosa	East Point	20	1transect		3	observe seabirds, harbor seals
	Ford Point	15	5	5		observe *Phragmatopoma*
	Fossil Reef	20				abalone and area photos, observe harbor seals, abalone
	Johnson's Lee	15	5	5		observe tidepool, *Phragmatopoma*
	Northwest Talcott	20	5		3	observe shorebirds, harbor seals
West Anacapa	Cat Rock	36	5			monitor shells on beach
	Frenchy's Cove	20				observe trampling, visitor impact
Mid. Anacapa	East and West	12(E)20(W)				observe harbor seals,
	Harbor Seal Arch		5			*Phragmatopoma*
Santa Barbara	Landing Cove	20				observe sea lions, urchins, seastars, algae, damaged areas, recovery
	Sea Lion Rookery	20	5			observe sea birds, sea lions



Data Sheets

The following data sheets are used to record information. Blank data sheets can be copied from the forms in this handbook (Appendix B).

Data Sheet #	Title
1	Study Site Map
2A	Abalone Plot Location Data
2B	Photoquadrat Location Data
3	Photoquadrat Description Log
4A	Photodata Log (# 1-#20)
4B	Photodata Log (#21-#40)
5	Black Abalone Density
6	Field Log
7	Photoquadrat Data
8	Black Abalone Size and Condition

Sheets 4A and 4B can be copied onto each side of one sheet of paper. Sheet 5 should be copied onto both sides of the paper.

Personal Gear Needed

Boots	Notebook
Day pack	Field guides
Foul-weather gear	Cloth gardening gloves
Wetsuit	Swim trunks
Booties/ tennis shoes	Old towels
Sunglasses	Knee pads
Hat or visor	Camera
Watch cap	Binoculars
First aid kit	Waterproof protective bag
Food and drink	(for camera and
Flashlight	binoculars)

Photoquadrat Sites

Establishing Intertidal Photoquadrats

Each area chosen for monitoring must have a high percentage of coverage of the target species and needs to be relatively flat but not necessarily horizontal. Photoquadrats are originally laid out in the intertidal area using a flat, rectangular rebar frame the size of the base of the quadrapod (50 cm x 75 cm) as a guide. At each corner of the chosen area, a space approximately 5 cm x 5 cm is cleared using wire brushes, chisels, hammers, or scrapers. Helor Hi-Water Epoxy is made according to manufacturer's directions. A small dollop is placed at each corner, pressed onto the rock, and smoothed to form an epoxy corner approximately 2-3 cm square. A pre-numbered brass tag is pressed into the upper left corner of the quadrat (when viewed from the seaward side) and smooth, hard plastic disks approximately 15 mm in diameter are pressed into the other three corners. (After a period of two or three years it is often very difficult to differentiate epoxy from natural surroundings while the hard plastic disks maintain their identity.) These epoxy corners should be installed on the outgoing

In mussel quadrats it is desirable to place as many corners as possible on raised ridges to prevent them from being overgrown. A bronze bolt in the upper or lower right corner (when viewed from the seaward side) is helpful in relocating quadrats in mussel or other plots prone to overgrowth.

NOTE: Careful descriptions, maps, and photographs should be taken to help relocate quadrats during subsequent surveys. Distances and compass bearings between quadrats will help relocate quadrats should all four corners be missing. Record information on quadrat locations on Data Sheet #2.

Equipment and Materials

Before each sampling period begins, check the status of equipment and materials. Replace epoxy, bronze bolts, film, and batteries as needed. Also check that the drill, camera, and strobes are in good working order, and that the drill batteries are charged.

For Site Establishment and Repairs

		LOCATION
2	5-gallon plastic buckets/ lids	Closet
2	Paint scrapers	Bucket
2	Wire brushes	Bucket
2	Rock hammers	Bucket
1	Chisel	Bucket
	Two-part epoxy, 1 set for each site	Closet
1	Mixing bowl	Bucket
1	Mixing knife	Bucket
	Pre-numbered brass tags	Closet

1-5	Rebar quadrat frames (used as guides)	Closet
	Plastic disks for quadrat corners 3/quadrat	Bucket
	Data Sheets, #1, #2, #3	Handbook

For Monitoring Photoquadrats

		LOCATION
1	Pelican case	Closet
1	Nikonos V camera	Pelican Case
1	28-mm land lens (LW28)	Pelican Case
2	Nikon SB 15 strobes	Pelican Case
2	Nikon SC 15 power cords--strobes	Pelican Case
1	Adapter for E-O plug	Pelican Case
1	3-way connector from E-O plug to power cords	Pelican Case
2	Strobe holders which screw into quadrapod	Pelican Case
1	Quadrapod frame & camera mount	Closet
2	Clipboards with rubber bands	Workroom
4	Pencils	Workroom
4	AA batteries for each strobe + extras	Cabinet
1	Roll/site, 36 exposure, Ektachrome 100 Slide Film	Cabinet
1	Each/site, data sheets 4A, 4B, and 6 (Field Log)	Workroom
	Area maps and quadrat location information	Workroom
1	Compass	Cabinet
1	Tape measure	Closet
	Plastic bags	
2	Waterproof bags for gear and papers	Closet
	Collecting vials, formalin, labels	Bucket
1	Thermometer	
	Towel	Optional

Monitoring Photoquadrats

Percent cover of the dominant organisms is determined in five intertidal zones using the random point contact method on slides taken of permanent photoquadrats in each zone. Generally five replicate photoquadrats are established in each zone; four zones are usually represented at a site, so twenty quadrats are photographed. The quadrats are photographed with 35-mm slide film twice a year during daylight low tides, fall and spring. Quadrat images are later projected nearly life-size onto a 100 point grid, and the number of points overlain by each of the monitored taxa is recorded to estimate abundance as percentage of area covered.

Personnel Required

Two people are necessary to shoot the photoquadrats; one to do the actual camera work and one to record data. A third person can work ahead finding the next quadrat and cleaning the corners. A fourth person can clean and repair photoquadrat corners.

Photographing Quadrats

Quadrat corners are located (using Data Sheet #2, quadrat location data in Appendix C), cleaned of growth, and repaired. Cleaning all corners with a wire brush or paint scraper is important during every sampling period as one year's growth can completely obscure the epoxy, making it impossible to find.

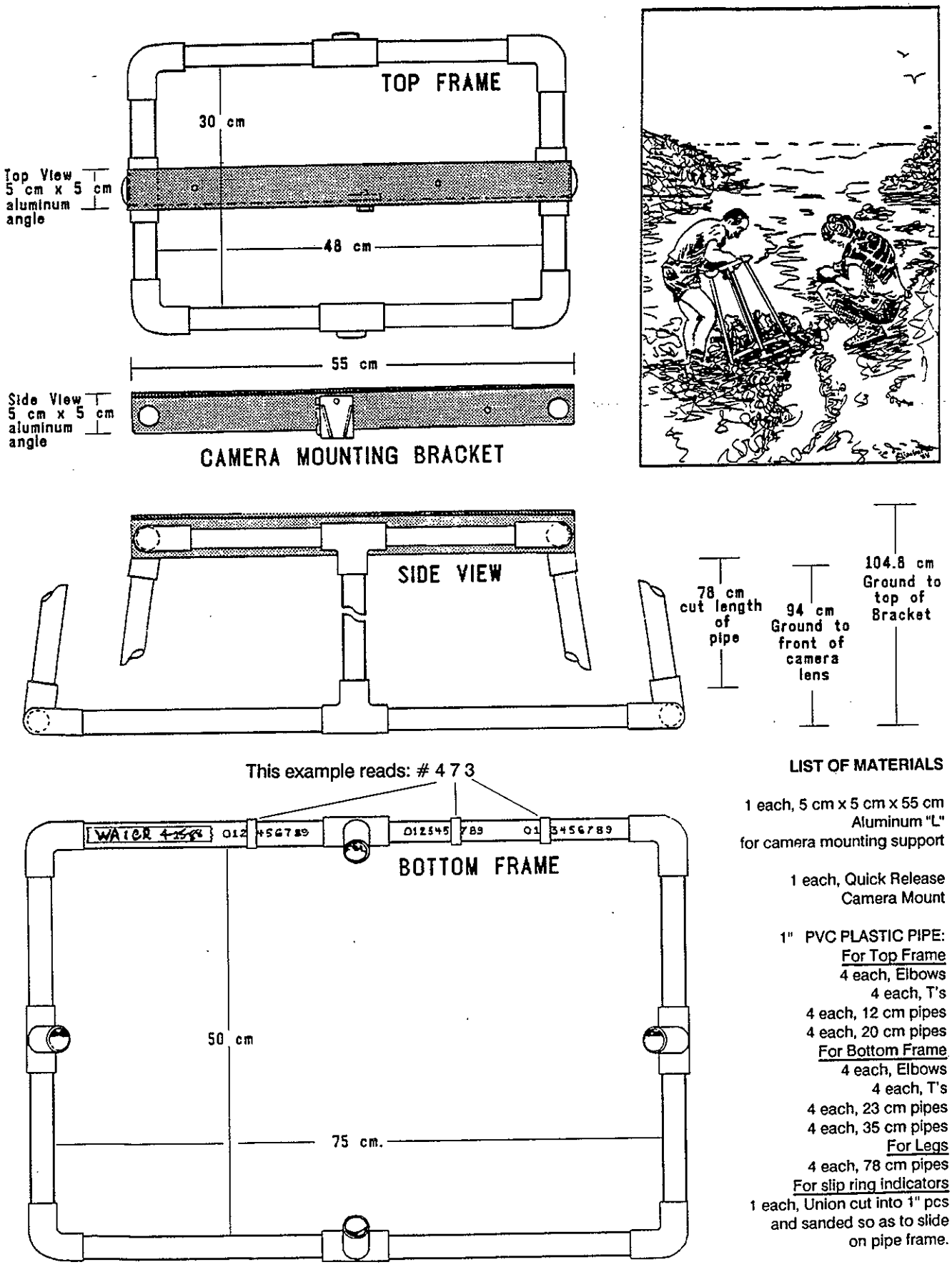
Pictures are taken using the quadrapod which places the camera and strobes directly over each quadrat (see Figure 2 for details for constructing a quadrapod). The corner with the numbered tag is generally placed in the upper left corner of the quadrapod frame and the remaining three epoxy/disk corners are lined up with the corners of the frame. There are three groups of numbers on the base of the quadrapod which are used as numbering reference guides (these will appear in the top of the photo). To change the counter number, slide the indicator rings to where they rest just to the left of the desired number digit, i.e. #s 4 7 3 in quadrapod drawing, Figure 2.

Using Ektachrome 100 slide film, the camera settings should be:

Shutter speed	1/60
f-stop	f-16
Focus	.9 m (just below the 1 m setting)

Strobe settings should be:
A1 and TTL

The LW 28-mm lens is water resistant, but will not stand submergence. The strobes are not water resistant and should be protected. Plastic bags over the strobes will protect them from spray; however, when plastic bags are over the strobes this will modify the light source and require all pictures to be "bracketed", i.e., three pictures are taken, one at f-8, one at f-11, and one at f-16.



LIST OF MATERIALS

1 each, 5 cm x 5 cm x 55 cm
Aluminum "L"
for camera mounting support

1 each, Quick Release
Camera Mount

1" PVC PLASTIC PIPE:
For Top Frame
4 each, Elbows
4 each, T's
4 each, 12 cm pipes
4 each, 20 cm pipes
For Bottom Frame
4 each, Elbows
4 each, T's
4 each, 23 cm pipes
4 each, 35 cm pipes
For Legs
4 each, 78 cm pipes
For slip ring indicators
1 each, Union cut into 1" pcs
and sanded so as to slide
on pipe frame.

Figure 2. Quadrapod Construction Details

Notes are kept on picture order, settings used, problems, and organisms present on the photoquadrat. Use Data Sheets #4A and #4B for this purpose. Extra film at the end of the roll can be used to shoot area photos and abalone plots. At some sites, photo points have been set up to document the intertidal area or feature from the same vantage point each monitoring season. Consult the area maps for directions. Use the daily field log (Data Sheet #6) to record weather information and pertinent data such as personnel, species lists, general description of site, work done, and repairs needed. Any pertinent observations are worth noting as they may prove important at a later date. Photoquadrat Logs, Abalone Plot Logs, and Daily Field Logs are stored in the appropriate island binder for use in labeling slides.

Photoquadrat Lab Procedure

Process film and label slides as soon as possible. Taking good notes during photography sessions will now help in properly labeling slides. Labeling should include station, quadrat number, and sampling date.

Slides are scored by projecting onto a 100 point 40 cm x 50 cm grid. Percent cover of the different taxa are determined by a random point contact method. By determining the cover at 100 random points an estimate of percent cover is derived. This size allows projection to nearly life size with room on the margins to allow some projection latitude. The use of a tally meter facilitates the counting of species under each point.

In addition to the five zone taxa catagories of other objects such as miscellaneous algae, miscellaneous animals, bare rock, tar, unidentifiable points, or the name of an abundant species are recorded. When layering is apparent as with barnacles or algae on mussels, but where mussels are the primary concern, the surrounding layers should be noted as a different category. This will preserve the accuracy of the primary data (100 points) and provide additional general information concerning the quadrat for future reference.

Time required to score one station of 20 slides is usually less than two hours.

Photo Interpretation Equipment

		LOCATION
1	Slide projector with stack loader	Interp. Room
1	100 point grid on white paper	Workroom
1	Intertidal photoquadrat Data Sheet #7 for each site	Workroom
1	Tally meter	Workroom
1	Darkened room for projection	Training Room

Black Abalone Plots

Establishing Plots

Fixed, permanently established plots approximately one to two square meters each are used for monitoring the size, movement, and abundance of black abalone.

Five such black abalone plots have been randomly selected at nine of the fifteen monitoring sites. These plots were chosen using the following guidelines:

- Each plot contained 30 to 100 black abalone
- Black abalone present are countable and measurable, i.e., no deep crevices
- Plot is high enough in the intertidal zone to allow sufficient time to work

Silicon bronze, hex head, 3/8 in. x 3 in. bolts are fused permanently in place with epoxy at corners such that a string around them will define the plot, and choosing high corner points for these bolts will make them easier to find in the future. Use a rechargeable hammer drill with a masonry bit to create a hole deep enough to bury at least one inch of the three inch bolt. Epoxy is pushed into the hole with the bolt and mounded up around the bolt and a prenumbered brass tag is sealed in epoxy next to the upper left bolt (when viewed from the seaward side). The rechargeable hammer drill will make two to six holes per battery, depending on the rock.

NOTE: Careful descriptions, maps, and photographs should be taken to relocate plots during subsequent surveys. Distances and compass bearings between plots will help relocate plots should all four corners be missing. Distances and angles between bolts will help in determining plot area and reestablishing corners.

Equipment and Materials

For Plot Establishment and Repair

		LOCATION
1	5-gallon plastic bucket with lid	Closet
	Two-part epoxy	Closet
1	Mixing bowl	Bucket
1	Mixing knife	Bucket
2	Paint scrapers	Bucket
2	Wire brushes	Bucket
1	Power drill w/extra batteries & drill bits	Closet
	Silicon bronze, hex head 3/8" x 3" bolts, 4/plot	Closet
	Brass pre-numbered tags	Closet
2	Star drills	Bucket
1	Hammer	Bucket
	Tubing to blow drill dust from holes	Bucket

For Monitoring

1	5-gallon plastic bucket with lid	Closet
2	10-m lengths nylon or polypropylene line	Bucket
2	Caliper gauges	Bucket
1	Tape measure	Closet
2	Waterproof lumber crayon	Bucket
2	Clipboards and pencils	Workroom
	Data sheets #5 and #6 for each site	Workroom
	Maps and quadrat location data	Workroom
	Pre-numbered brass tags	Closet
	Stainless steel wire	Closet

Monitoring Black Abalone Plots

Personnel Required

Volunteers can be utilized to help with data recording and also help with measuring if shown the proper methods. Two people are essential; one to measure abalone and the other to record data. Do not assume that everyone knows the proper way to measure abalone or even identify an abalone from a limpet!

The time requirements discussed in reference to the individual island sites are based upon a minimum crew of four people where abalone measurements and photoquadrats are performed simultaneously.

Physical ability is important because of the amount of hiking and difficulty of the terrain, particularly on San Miguel Island.

Plot Monitoring Methods

The number and sizes of black abalone are monitored twice a year when the photoquadrats are photographed. Black abalone have been tagged at sites on Anacapa, San Miguel, and Santa Rosa islands in cooperative studies with California Fish and Game. Tag numbers of these tagged abalone in the plots should be noted.

Monitoring plots are defined by string or nylon line around the four corner bolts. Using a caliper gauge, all black abalone inside or under the string are measured across the longest part of the shell. (The abalone are measured without removal from the rocks.) The sizes are noted by the recorder on Data Sheet #5. After measuring, the shell is marked with a waterproof crayon to avoid duplicating measurements. Because of irregularities in the rock, some abalone cannot be measured and are noted as such or a best estimate is given and noted on the data sheets with an approximate sign.

At sites with previously tagged abalone (Anacapa), a search is made for these individuals, including outside the plots, and their length and distance from the upper left bolt of the nearest plot is noted.

At Santa Rosa Island, East Point, a transect running between two mussel quadrats is used for abalone sampling. The transect runs from the bolt in upper right corner of photoquadrat #590, south 18 meters to the bolt in upper right corner of photoquadrat #593. Abalone within 1.5 meters of each side of the transect line are measured and recorded as noted above. (Note - The entire length of the transect is not used because of the difficulty measuring the abalone in the surge channel.)

Data collection on abalone condition began in 1987 because of observations of abalone decline and die-off. Shell measurements and total weights are taken from collected abalone. Empty shell data can be useful also. At present four conditions categories are used to measure abalone condition.

- Shell only
- Dead
- Healthy
- Unhealthy

The health of abalone are determined by their ability to attach to rock (unhealthy abalone are easily pulled off by hand). Activity and muscle size are also considered in the determination of health.

Fouling of the shell is observed and recorded using the following four subjective categories.

- Clean - no growth on the shell
- Light - only a small amount of barnacles or algae (<5%cover)
- Moderate - 5 to 30% cover
- Heavy - 30% of more cover or a large barnacle or growth that definitely affects the weight of the abalone

All pertinent abalone information should be recorded on Data Sheet #8.

Owl Limpet Plots

In 1987 owl limpet (*Lottia gigantea*) plots were established at several sites. At Johnson's Lee and Ford Point (Santa Rosa Island), bolts and numbered brass tags were set into the rock. Monitoring is accomplished by counting and measuring the owl limpets within a 0.5 m circle around the bolt. At Otter Harbor (San Miguel Island) owl limpets are counted in a abalone plot (#369) and in a 2-m wide transect between bolts 367 (upper left corner of abalone plot 367) and bolt 496 (installed for the transect) approximately 8 m to the west. At Crook Point (San Miguel Island) owl limpets are monitored in plots 391, 392, and 393. Owl limpet data are recorded on Data Sheet #5 (abalone density). The abalone data computer programs can be modified to accommodate the owl limpet data, but as of 1988 no data management program has been developed.

Sea Star Monitoring

Sea stars (*Pisaster ochraceous* and *P. giganteus*) should be counted in each abalone plot at all sites. Crook Point (San Miguel Island) is the only site that consistently has sea stars in the plots. A transect 20 m long and 2 m wide running along the outer reef near abalone plot 515 at Johnson's Lee on Santa Rosa Island is used to count sea stars, but a permanent transect has not been established. Any sun stars (*Pycnopodia heliathoides*) should be noted at sites. General observations on sea stars are also helpful. Sea star counts are recorded on Data Sheet #5 (abalone density).

DATA MANAGEMENT

Photoquadrat Data

Introduction

All programs and data files are on hard disk on the resource management Sperry computer. Backups of both programs and data files should be on floppy diskettes in that area. After data is entered and checked for accuracy new backup copies should be made. The programs are written to be as user friendly as possible, however basic computer knowledge is a must as is some general familiarity with dBase III and SPSS/PC+ programs since detailed steps require constant changes with new program editions.

dBase III Plus is used for data management of the photoquadrat data. For summarizing the data and generating reports, the statistical software package SPSS/PC+ is used. Once the data is entered into dBase III files, the SPSS/PC+ translate program is used to translate the dBase III data file into an SPSS file. SPSS programs are then used to summarize the data and create a report.

dBase III Plus file structure for photoquadrat data:
(all fields are numeric)

Field # & Name	Width	Comments
1 Station	2	Location code number
2 Year	2	Last two digits of the year
3 Month	2	Month number (1-12)
4 Quadrat	3	Quadrat number
5 Bare Rock	3	Percent cover*
6 Acorn Barnacle	3	Percent cover*
7 Turf Weed	3	Percent cover*
8 Rock Weed	3	Percent cover*
9 Mussel	3	Percent cover*
10 Red Algal Turf	3	Percent cover*
11 Misc. Algae	3	Percent cover*
12 Misc. Animals	3	Percent cover*
13 Sand	3	Percent cover*

*as determined from random point contact

One dBase III file contains all the intertidal photoquadrat data for all years, and is stored on the hard disk under C: PHOTO.DBF

Entering Data and Updating Existing Files

The programs discussed in this section (PHOTO.TRN, PHOTO.RPT, PHOTO.TAB, ABS.RPT, and ABSHELL.RPT) are included in Appendix D.

Enter dBase III, once at the dot, type the commands:

. use c:PHOTO.DBF
[accesses file]
. append from c:TIDEBLK.DBF
[adds 60 blank records to the file]
. locate for station = 0
[locates the first record of the station (blank files)]
. replace next 20 station with__
[__enter location code for the station you are entering]
. go __ [__enter record number of the first record for that station given with the third command]
. replace next 20 month with __
[__enter month for data you are entering]
. go __ [same as fifth command]
. replace next 20 year with __
[__enter year for data you are entering]
. go __ [same as fifth command]
. browse [puts you in the data base file at the first record for that station]

You can now move over to the quadrat column and start entering data. Use the photoquadrat score sheets for data entry. If a species is not used in scoring, enter 999 (Use the replace command).

Make sure that you close the file when you are done editing. To do this enter the following commands

Press Ctrl End

[Exits and saves file]

. Close all

[Closes all data bases]

Data Analysis and Report Making with SPSS/PC+

Enter SPSS and the \TIDEPOOL subdirectory.

Run PHOTO.TRN, by typing **INCLUDE PHOTO.TRN** at the SPSS command, which translates the dBase file into an SPSS file labeled PHOTO.SYS. This program also calculates the percent cover from the total number of points scored, creates visible labels and sorts the data by station, then by year, before saving to PHOTO.SYS. This program only needs to be run after changes are made to the dBase file. All records are stored in this file so all reports can be printed using PHOTO.SYS.

To print a report, call up PHOTO.RPT. This program uses PHOTO.SYS and creates a report broken into zones by year and month with summaries of the mean abundance of the replicate quadrats for each taxa, the standard deviation and total number of points scored. The reports will have titles with the station names but changes will have to be made for each report. Changes to the program will not be saved unless you write the program to a file.

Changes that must be made for each report are:

(1) Replace *** with appropriate quadrat numbers at each SELECT IF statement in the second half of the program. Quadrat numbers are given in the comments immediately below the select statement.

(2) Replace station name and table number in title. Table numbers are given in the comments below quadrat numbers.

(3) If reporting Landing Cove, Santa Barbara Island, additional changes need to be made to the turfweed report. Replace PENDO with PTURF, and replace PMISCALT with PMISCAL in VARIABLES statement, SUM=MEAN statement, and SUM=STDEV statement. Replace TURFWEED ZONE in the title with RED-ALGAL TURF ZONE.

These changes are temporary and are not saved.

Because of the experimental quadrats at Cat Rock, West Anacapa Island, a separate program has been written. WAICR.RPT will print a report for Cat Rock, no changes are needed for the printout.

Review the output in the upper window of SPSS review. Block and write the table to a temporary file to print out.

Tables can also be created using PHOTO.TAB. This program also uses PHOTO.SYS created by translating the dBase file. Call up the file to make the changes listed in the first comments statement. The output will be saved to a diskette in the B: drive and no further editing should be necessary. As of August 1988, this program still has a minor bug or two and will not separate experimental treatments at WAICR.

Abalone Data

The raw intertidal abalone data is all stored and processed using SPSS/PC+. At present all data and programs are in the TIDEPOOL directory on the hard disk of the resource management Sperry computer with backup files on floppy diskettes. All data is entered using the REVIEW editor in SPSS. Data entry and reporting are straight forward, however the operator should be familiar with SPSS first, as it is impossible to give all the details in the instructions here.

From the main menu enter SPSS and then the tidepool subdirectory. Once in SPSS call the file you need in order to enter data or print reports.

Entering Data

SPSS file structure for abalone data

Field Name	Columns
Station	1-2
Month	4-5
Year	6-7
Plot 1	9-11
Plot 2	13-15
Plot 3	17-19
Plot 4	21-23
Plot 5	25-27

See the report program for the station code numbers. The following are the black abalone data files in the TIDEPOOL directory:

SBIABS.DAT = SBI SEA LION ROOKERY
SRIABS.DAT = SRI FORD POINT
SRIJABS.DAT = SRI JOHNSONS LEE
SRIEPABS.DAT = SRI EAST POINT
SRINWABS.DAT = SRI TALCOT
SMIHABS.DAT = SMI HARRIS POINT
SMICPABS.DAT = SMI CROOK POINT
SMIOHABS.DAT = SMI OTTER HARBOR
WAIABS.DAT = WAI CAT ROCK
MAIABS.DAT = MAI HARBOR SEAL ARCH

Enter the station number in the first two columns, the date in columns 4-8, followed by the data in millimeters for each of the five plots. The plots are set up in the file with lowest to highest plot number, left to right. Since some plots have been renumbered because of tag replacement, refer to the original plot number for entry sequence (the actual plot number is not entered into the data file). The station and date can be entered once and copied for efficient data entry. After entering station and date, block the line (**F7**) and copy it (**F8**) for as many new entries as you wish to make. Enter one plot at a time, moving about with the arrow keys. Save the file, after checking the numbers, by writing it to the disk (**F9**). At this point you will still be in the same file and can continue to edit or append data or you can exit SPSS or go to another file. If you do not save the file the program will ask if is OK to discard when you try to leave the file. Save it or you will be reentering the data. At this point continue to edit or append the same data file, or press **F10** to leave SPSS, or press **F3** to go to another program.

Report Program

Calling up \TIDEPOOL\ABS.RPT brings up the file defining variables in the data files and creating the report. The report gives summary information on totals for each plot and for the station as well as the percentage breakdown of size classes, mean, maximum, and minimum sizes. Comments in the report give the information needed for plot numbers and station codes. When printing a final report, a few changes need to be made in the program. On the first line the data file name should be changed to the appropriate name. The plot numbers must also be changed. (For Santa Rosa Island, East Point, label Quad 1 as Transect, delete the other plots from the variable list in the report command, and make the label 8 spaces long--do not forget to move the period!). The only other change is the station title. Change Table # for output file and title.

Run the file (**F10**). Changes should not normally be saved. There is an additional section in this program which will produce a histogram of size frequencies. This histogram can be produced at the same time as the other data, or left off and run at a later date.

The report OUTFILE will be saved to a file on the B drive with the name of the table (e.g. Table 20.RSL) so be certain to have a diskette in the B drive. Further editing of the report can be done in a word processing program. To examine the report without saving it to a diskette, just delete the SAVE OUTFILE line, and run the report.

Weight Measurement Data

Data on black abalone size and condition are entered into a dBase III file called ABSHELL.DBF. Regression analysis of the data is run from an SPSS/PC+ program named ABSHELL.RPT.

dBase III Plus file structure for plot data
(all fields are character fields)

Field # & Name	Width	Comments
1 Station	2	Station code
2 Condition	1	Condition code[1]
3 Weight	3	Weight (g)
4 Length	3	Length (mm)
5 Width	3	Width (mm)
6 Volume	3	Volume (ml)
7 Fouling	1	Fouling code[2]

[1] [condition code: 1 = empty shell, 2 = healthy animal, 3 = moribund, 4 = dead]

[2] [fouling code: 0 = clean, 1 = light, 2 = moderate, 3 = heavy]

Enter dBase III; once at the dot, type the commands:

. use c:ABSHELL.DBF
[accesses file]

. append from c:SHELBLK.DBF
[this adds 60 blank records to the file]
. locate for station = 0
[this locates this first record of the station (blank files)]
. replace next __ station with __
[enter station location code]
. go __
[enter record number of the first record for that station given with the third command]
. replace next __ month with __
[enter month of data being entered]
. go __
[same as fifth command]
. replace next __ year with __
[enter year of data]
. go __
[same as fifth command]
. browse
[to obtain the data base file that is the first record for that station]

Now move over to the weight column and start entering data. Use the black abalone size and condition sheets for data entry.

Make certain the file is closed when editing is complete. To do this enter the following commands:

Press Ctrl End [Exits and saves file]
. Close all [Closes all data bases]

To run a regression curve with this data, enter SPSS, call up ABSHELL.RPT. If new data was entered into the dBase file since the last translation, run the entire program by blocking and running it. If no changes have been made to the dBase file, just run the file from GET FILE='ABSHELL.SYS' statement to the end. Adjust SELECT IF statements as necessary.

REFERENCE LIST

Abbott, I. A. and G. J. Hollenberg. 1976. Marine algae of California. Stanford University Press, Stanford CA. 827 pp.

Foster, M.S., A. P. DeVogelaere, C. Harrold, J. S. Pearse, and A. B. Thum. 1986. Cases of spatial and temporal patterns in rocky intertidal communities of central and northern California. Prepared for the Minerals Management Service, U.S. Dept. of Interior by Kinnetic Laboratories, Inc. in association with Moss Landing Marine Laboratories under Contract No. 14-12-0001-30057. Vols. 1 and 2. OCS Study MMS 85-0049. 126 pp.

Hardin, D., L. Kiguchi, C. Harrold, A. DeVogelaere. 1986. Study of the rocky intertidal communities of central and northern California. Year 1. Minerals Management Service. Contract No. 14-12-0001-30057. Los Angeles, CA. 448 pp.

Morris, R. H., D. P. Abbott, and E. C. Haderlie. 1980. Intertidal invertebrates of California. Stanford University Press, Stanford, CA. 690 pp.

Smith, R. I. and J. T. Carlton (eds.) 1975. Light's Manual: Intertidal invertebrates of the central California coast. Third edition. University of California Press, Berkeley. 416 pp.

VTN Oregon, Inc. 1983. Visitor impact and recovery on Channel Islands tidepools: Final report. National Park Service, Contract No. CX 8000-1-0054, Ventura, CA. 80 pp.

VTN Oregon, Inc. 1984. Visitor impact on tidepools, field and laboratory handbook. National Park Service, Contract No. CX 8000-1-0054, Ventura, CA. 26 pp.

APPENDIX A. Location of Rocky Intertidal Monitoring Sites.

The following maps indicate the general locations of monitoring sites on each island. The island maps are followed by a series of specific drawings that indicate locations of photoquadrats and plots within each site. Data locating thephotoquadrats and plots (bearings and distances between quadrats) are found in Appendix C.

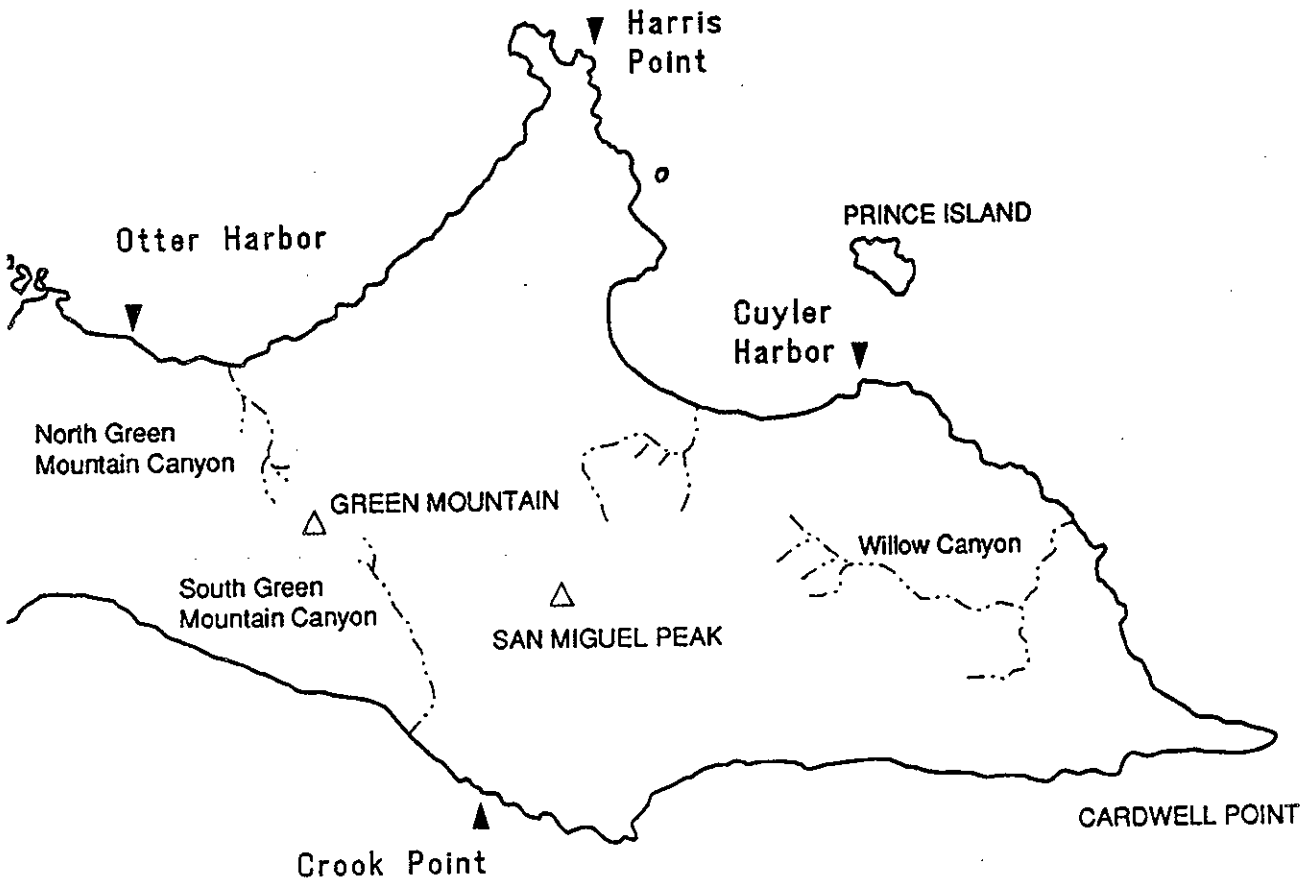
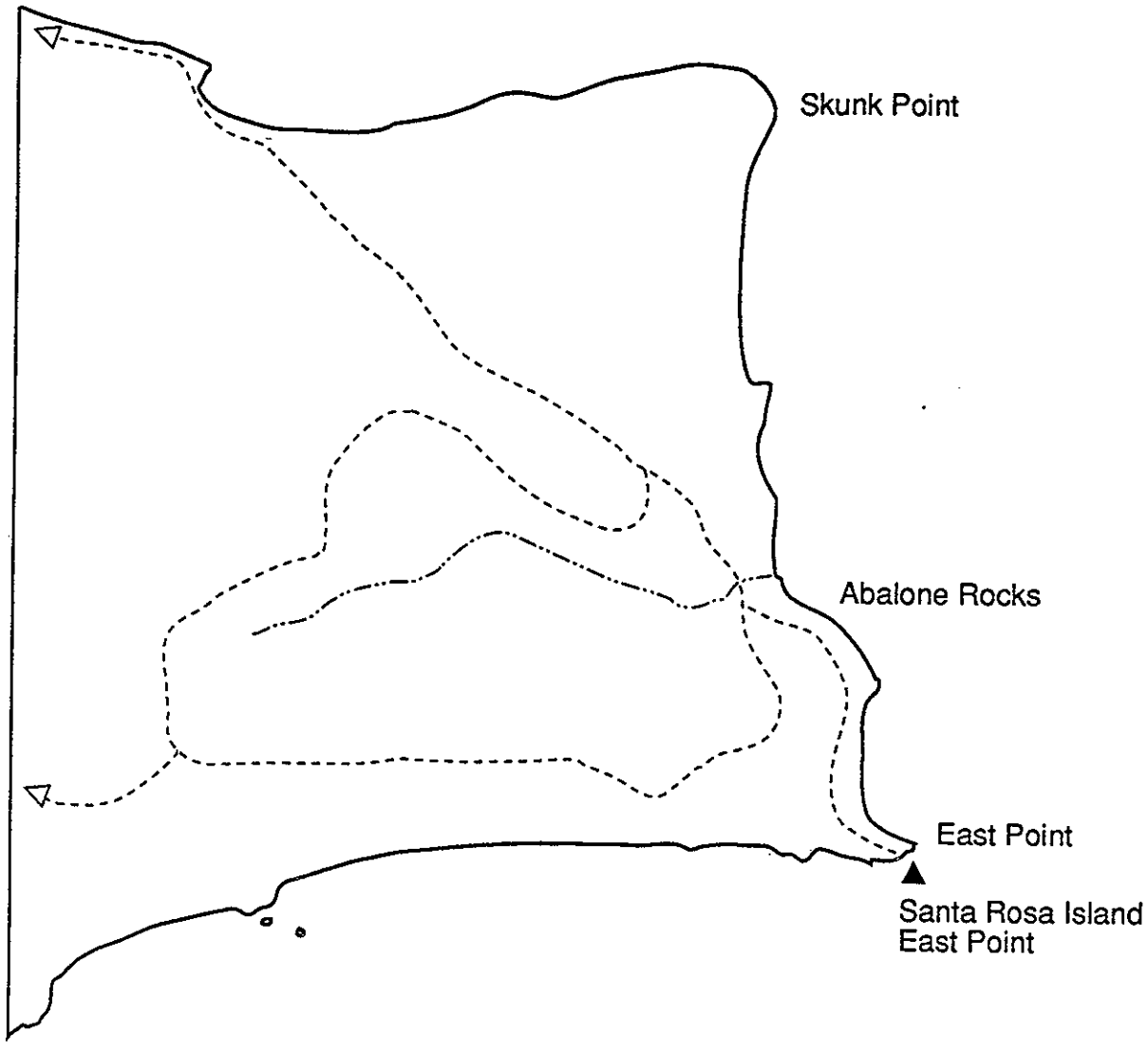
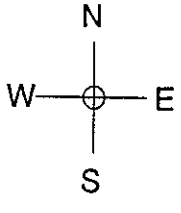


Figure A - 1. SAN MIGUEL ISLAND

Intertidal Monitoring Sites





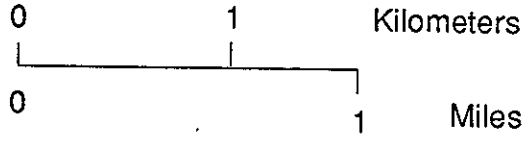


Figure A - 2. SANTA ROSA ISLAND

Intertidal Monitoring Sites

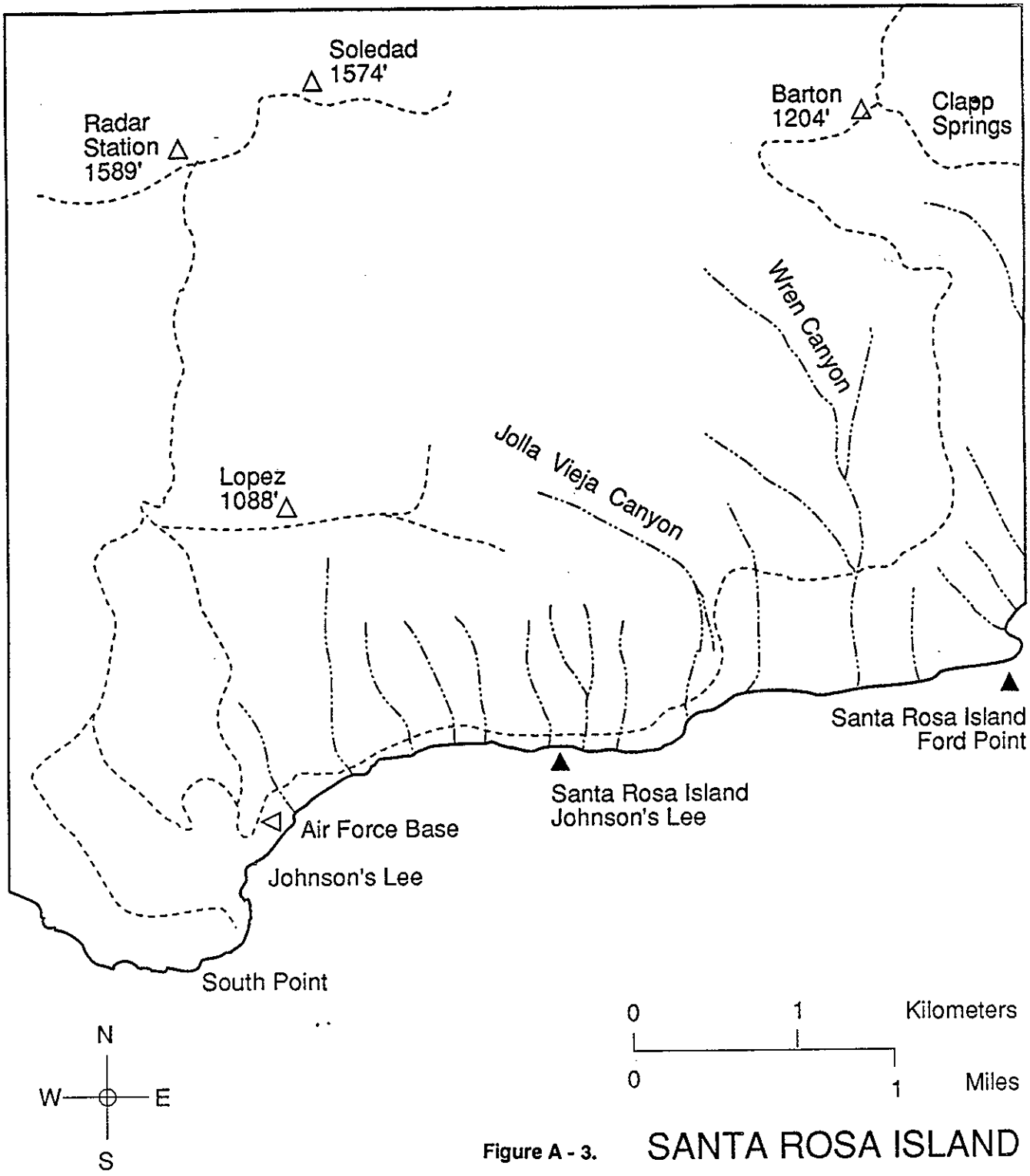
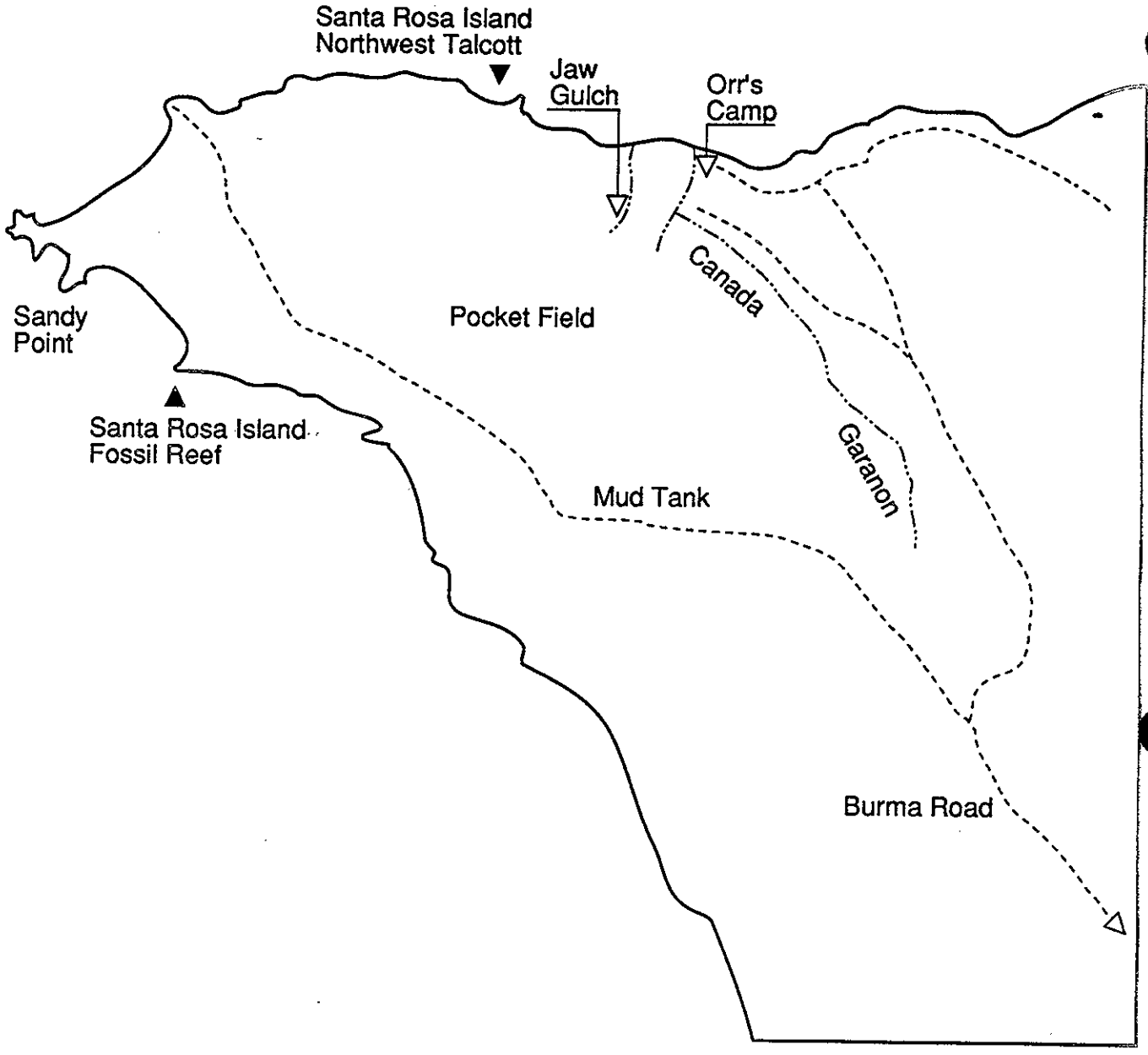


Figure A - 3. SANTA ROSA ISLAND

Intertidal Monitoring Sites



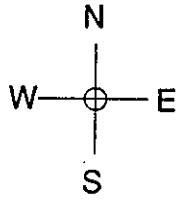


Figure A - 4. SANTA ROSA ISLAND

Intertidal Monitoring Sites

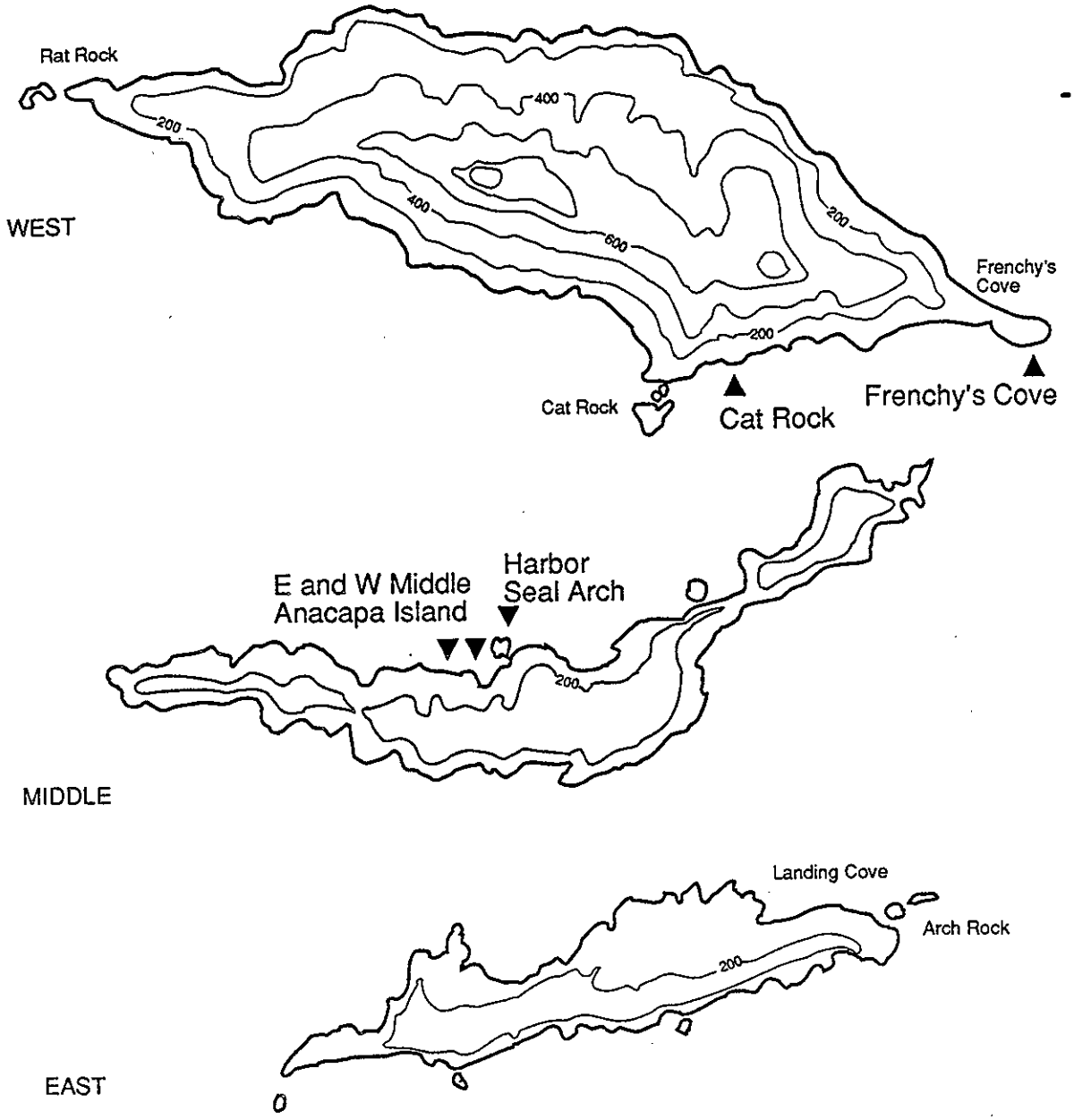


Figure A - 5. ANACAPA ISLAND

Intertidal Monitoring Sites

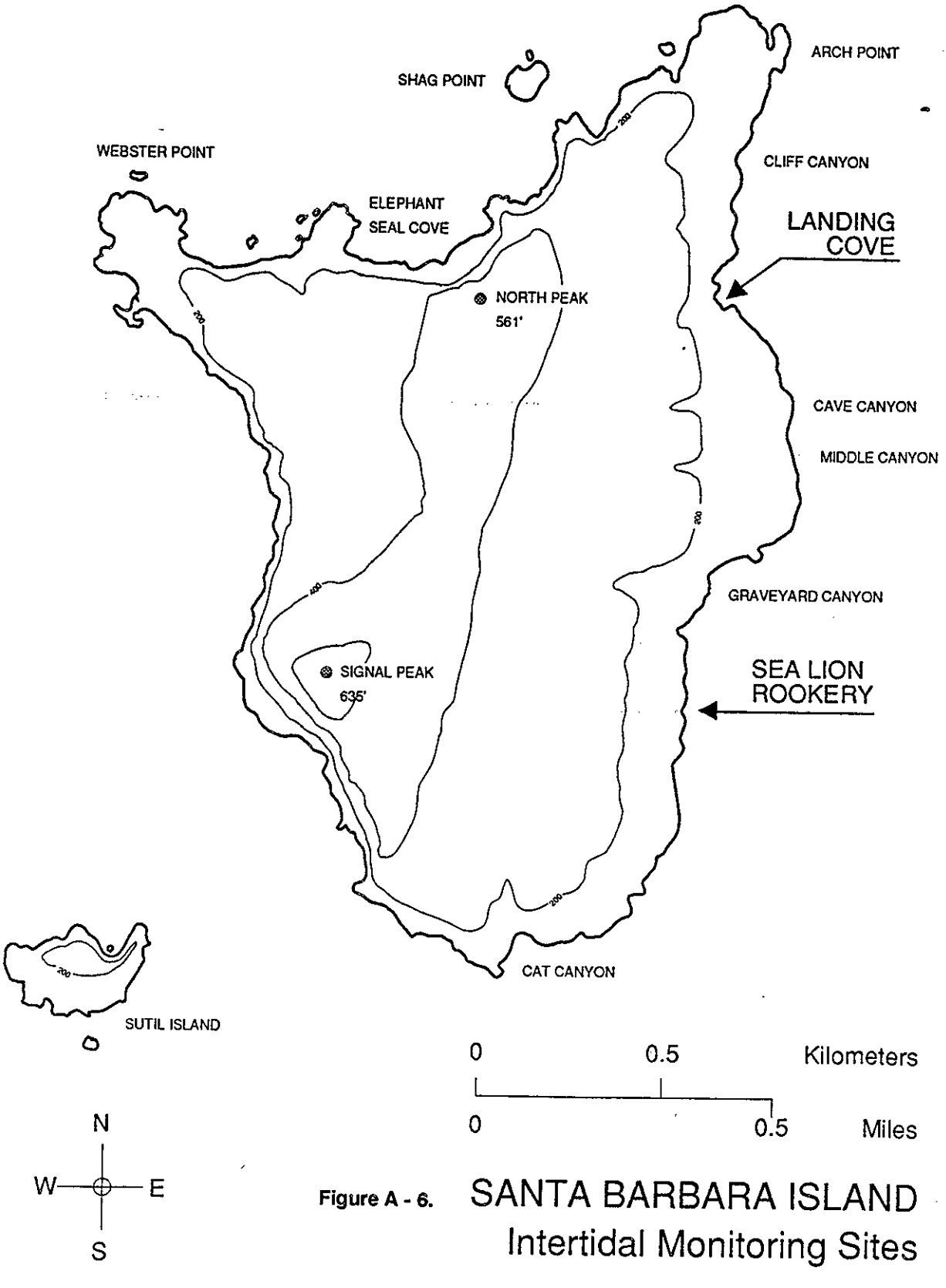
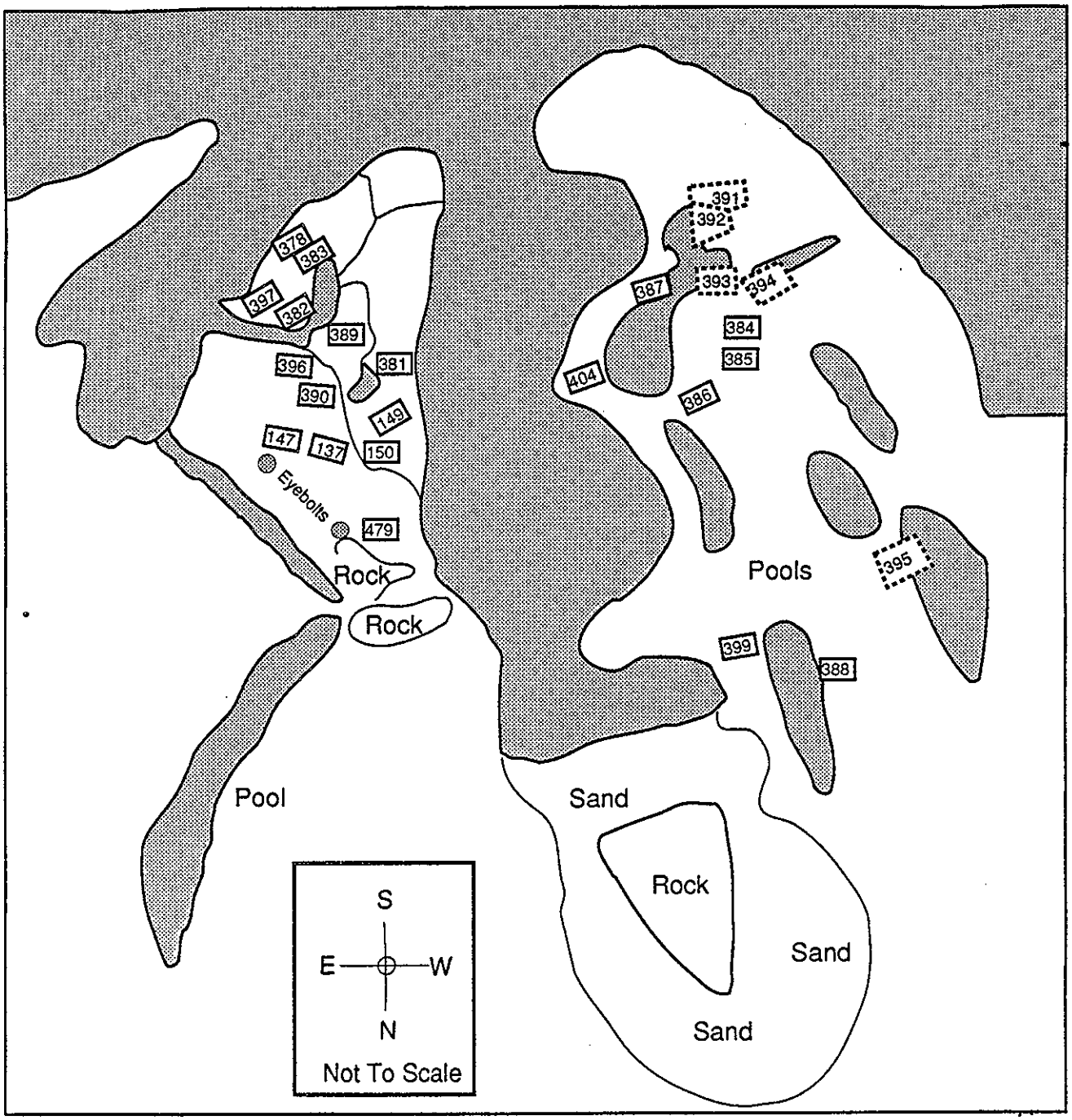


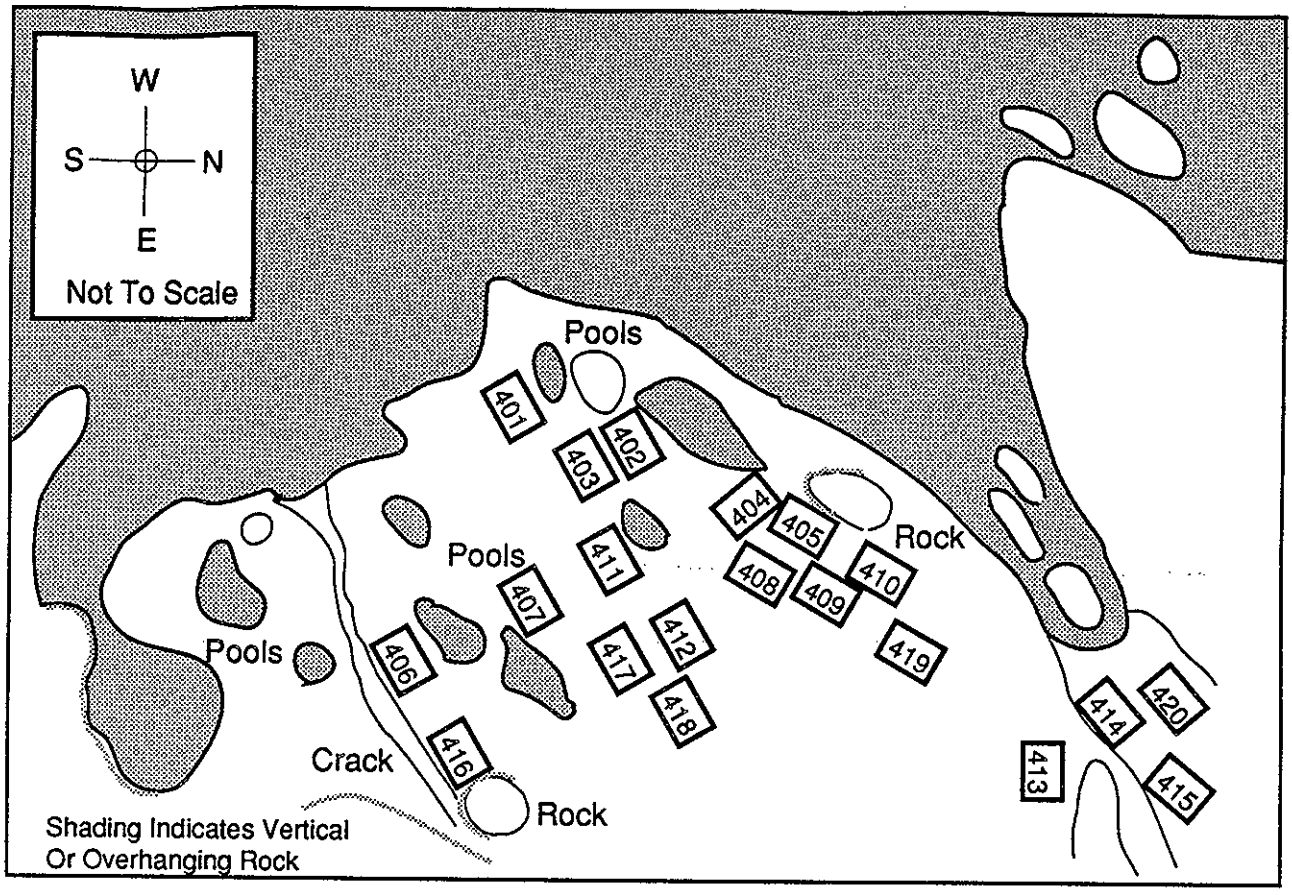
Figure A - 6. SANTA BARBARA ISLAND
Intertidal Monitoring Sites



QUADRAT NUMBERS

▭	Barnacle	137 - 150, 479
	Endocladia	386 - 390
	Mussel	381 - 385
	Rockweed	396 - 400
⬚	Abalone Plots	391 - 395

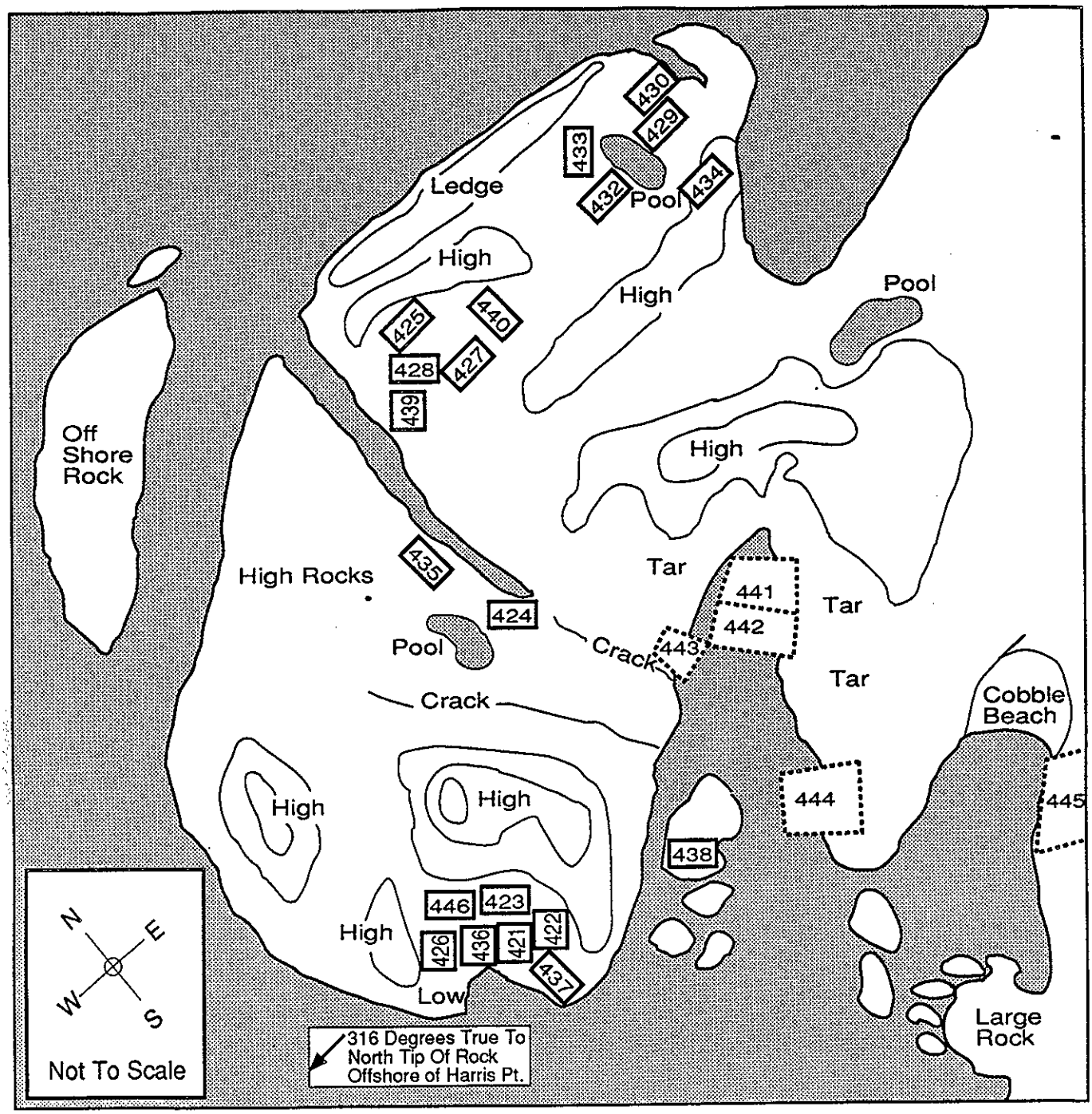
Figure A - 7. SAN MIGUEL ISLAND
Crook Point
Intertidal Monitoring Site
Established March 1985



QUADRAT NUMBERS

Barnacle	416 - 420
Endocladia	411 - 415
Mussel	401 - 405
Rockweed	406 - 410

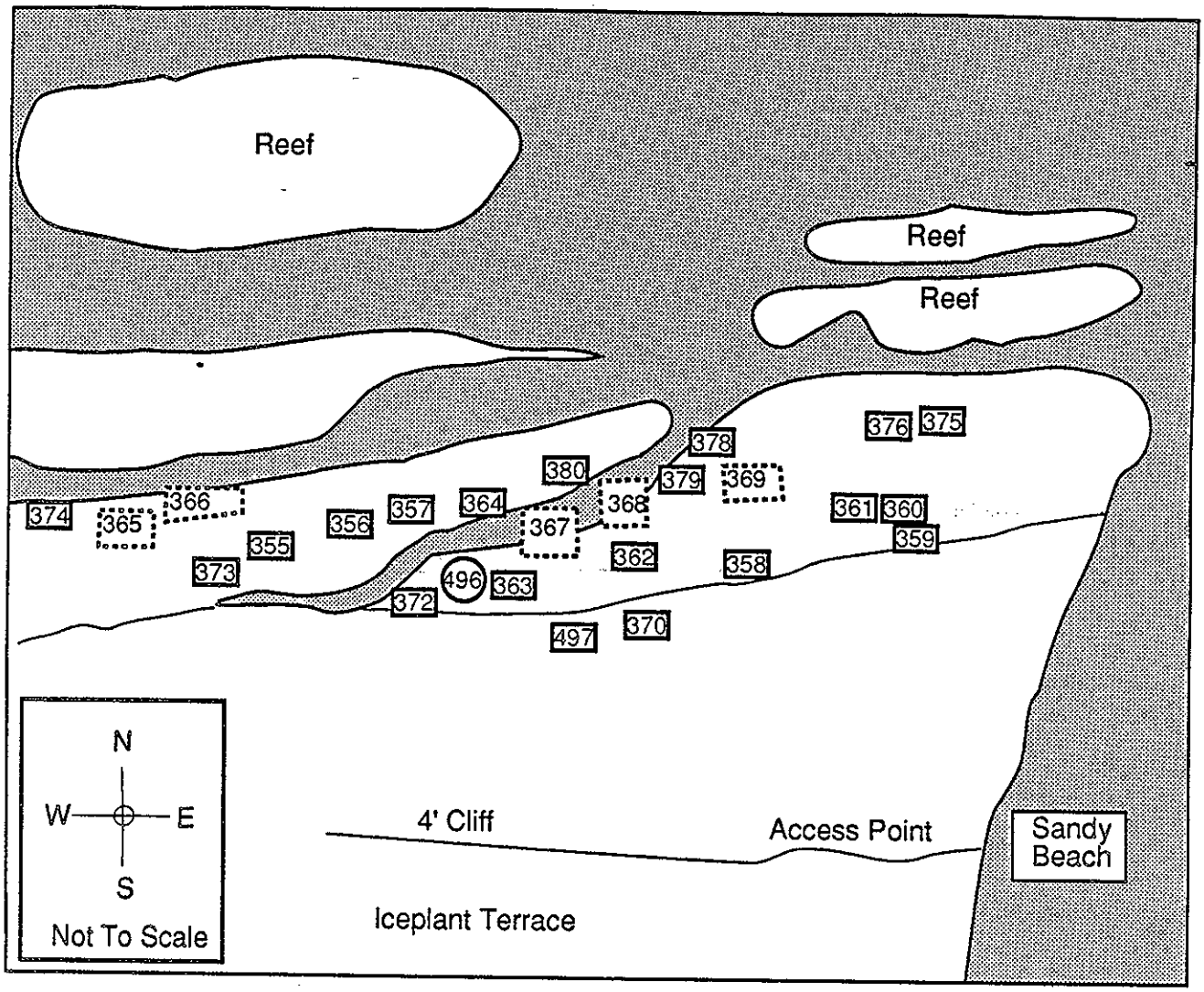
Figure A - 8. SAN MIGUEL ISLAND
Cuyer Harbor
Intertidal Monitoring Site
Established April 1985



QUADRAT NUMBERS

Barnacle	436 - 440
Endocladia	431 - 435
Mussel	426 - 430
Rockweed	421 - 425
Abalone Plots	441 - 445

Figure A - 9. SAN MIGUEL ISLAND
Harris Point
Intertidal Monitoring Site
Established April 1985

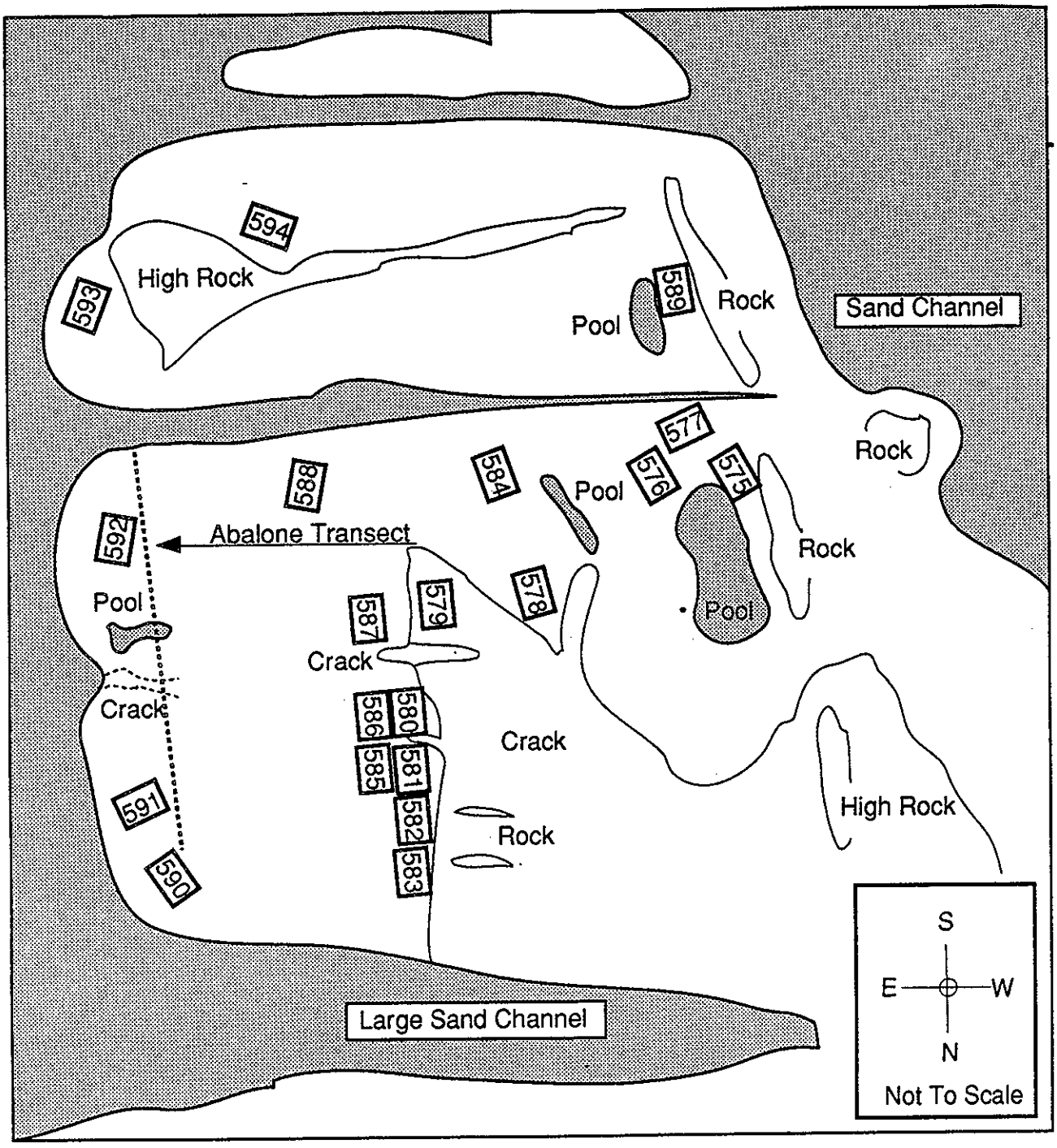


QUADRAT NUMBERS

▭	Barnacle	370 - 374, 497
	Endocladia	360 - 364
	Mussel	375 - 380
	Rockweed	355 - 359
▭	Abalone Plots	365 - 369
○	Lottia	496 Bolt For Transect

Figure A - 10. SAN MIGUEL ISLAND
Otter Harbor
Intertidal Monitoring Site

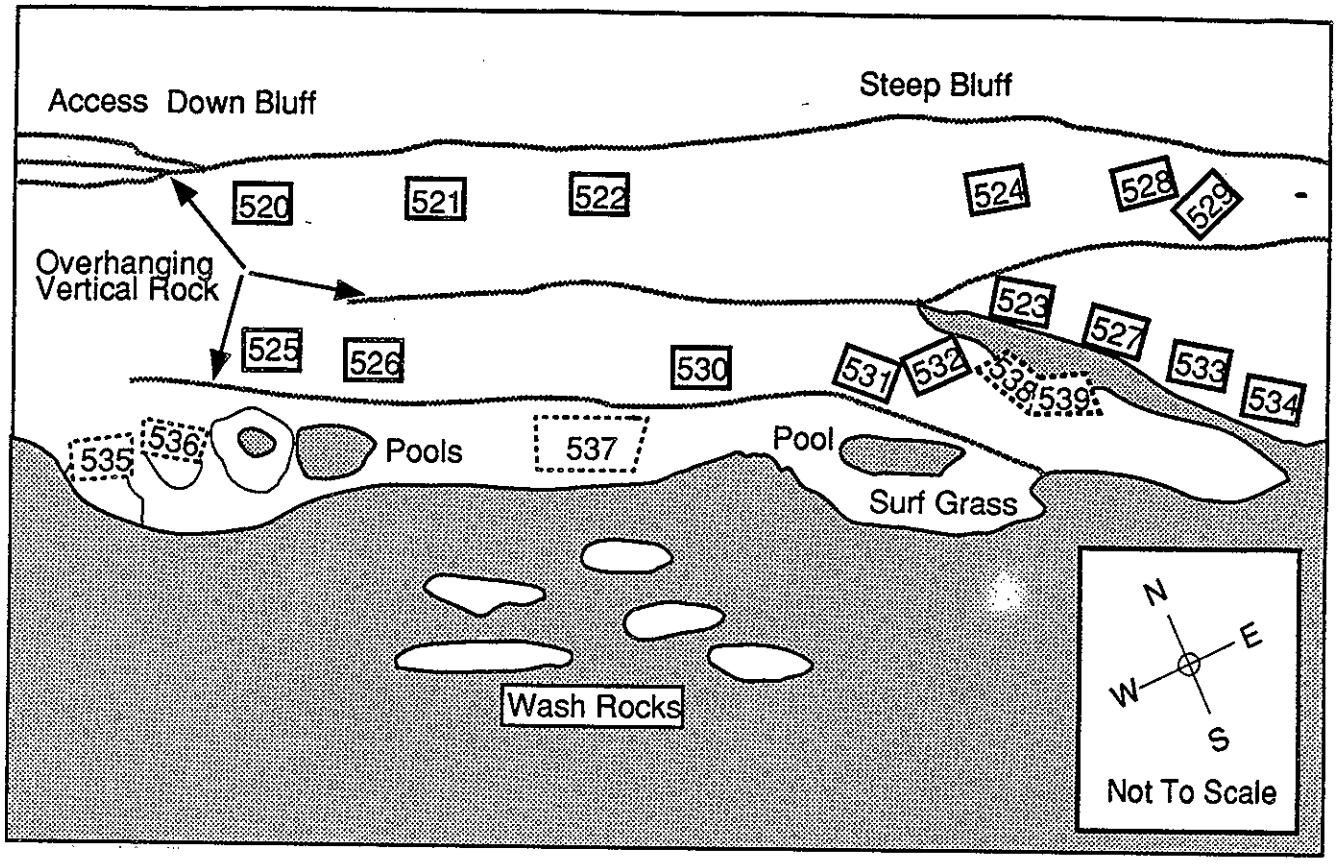
Established March 1985



QUADRAT NUMBERS

Barnacle	575 - 579
Endocladia	580 - 584
Mussel	590 - 594
	Bolt in upper right corner of mussel quadrats
Rockweed	585 - 589

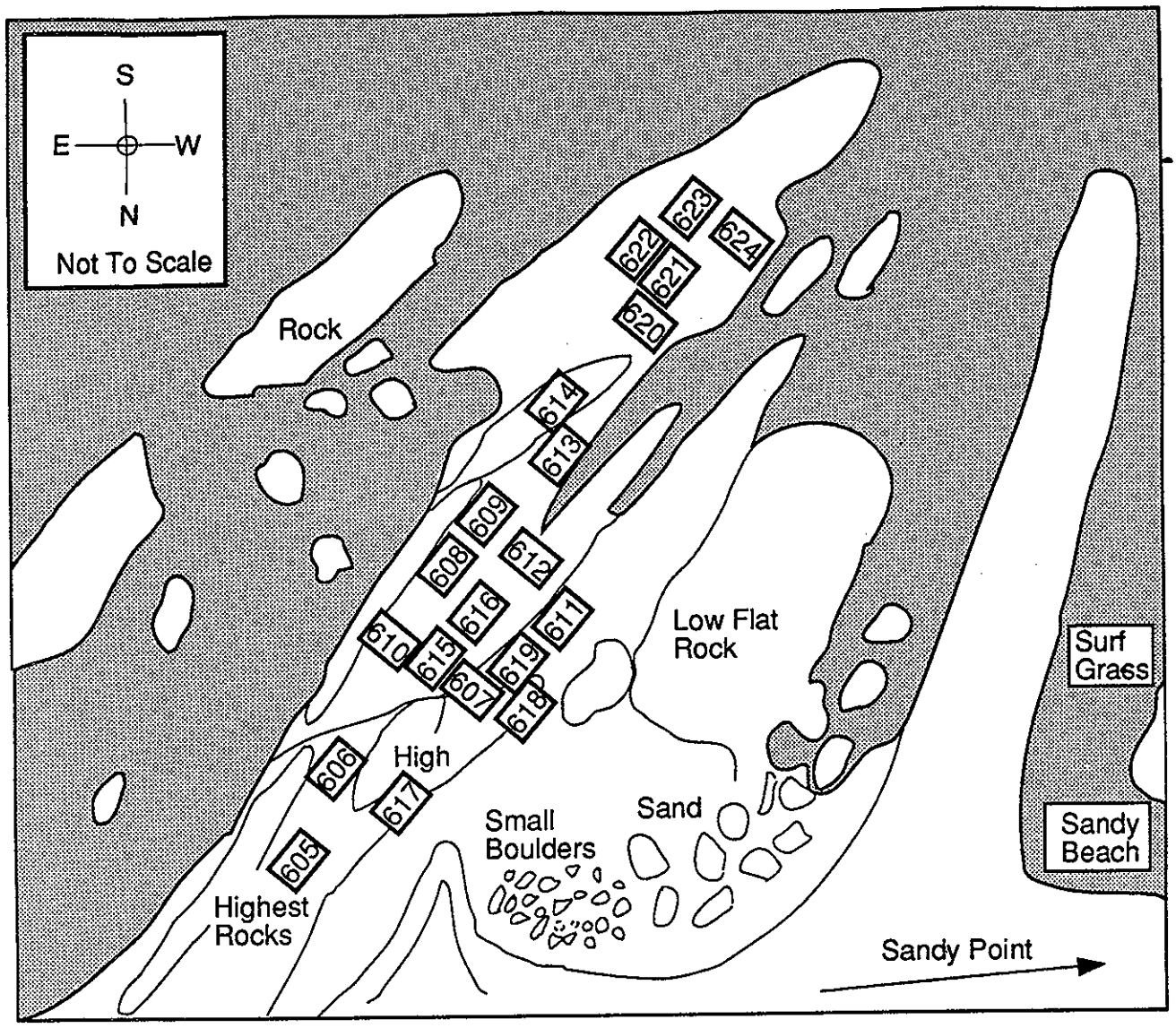
Figure A - 11. SANTA ROSA ISLAND
East Point
Intertidal Monitoring Site
Established December 1986



QUADRAT NUMBERS

Barnacle	520 - 524
Endocladia	525 - 529
Mussel	530 - 534
Abalone Plots	535 - 539

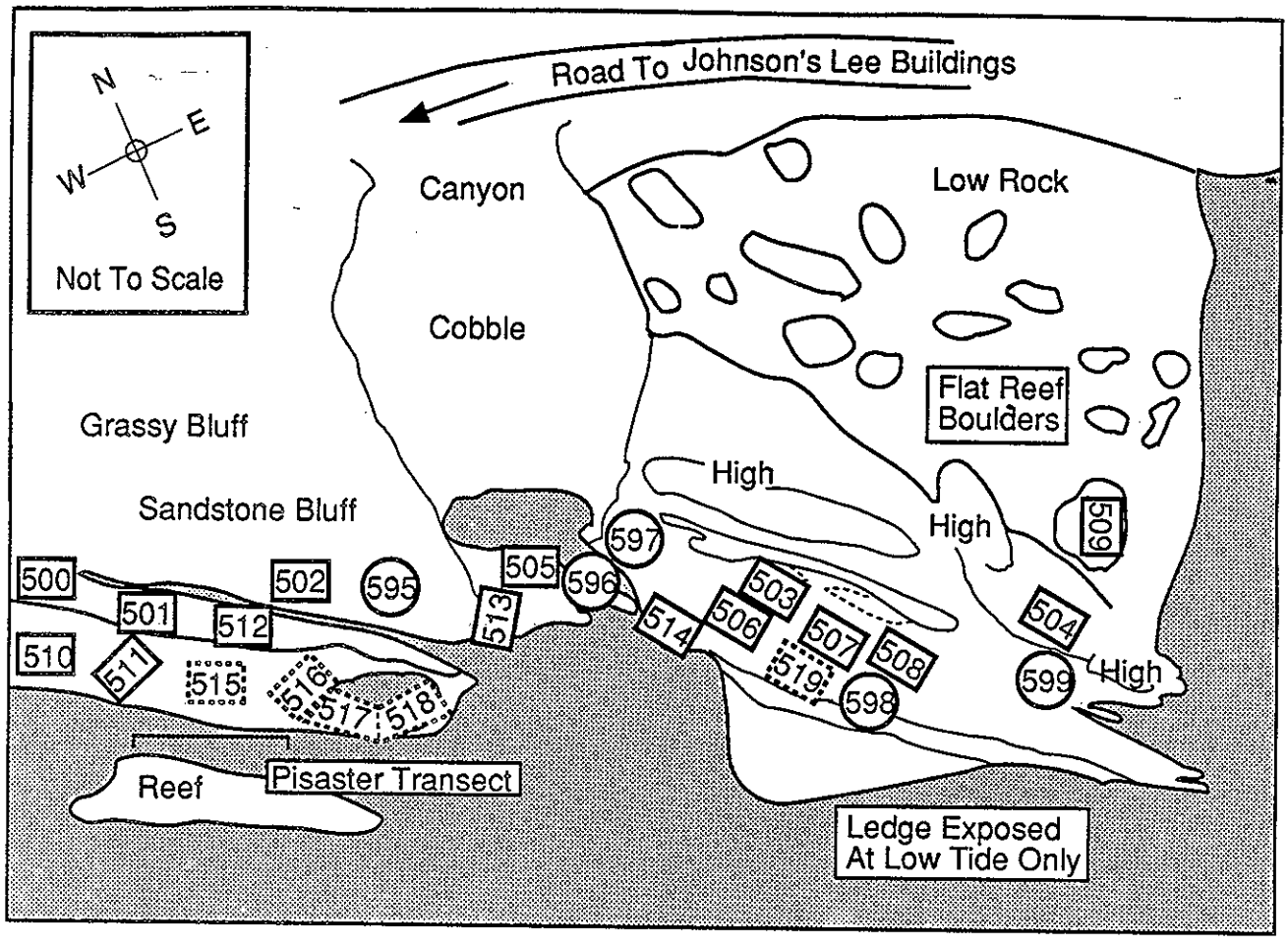
Figure A - 12. SANTA ROSA ISLAND
Ford Point
Intertidal Monitoring Site
Established December 1985



QUADRAT NUMBERS

Barnacle	605 - 609
Endocladia	610 - 614
Mussel	620 - 624
Rockweed	615 - 619

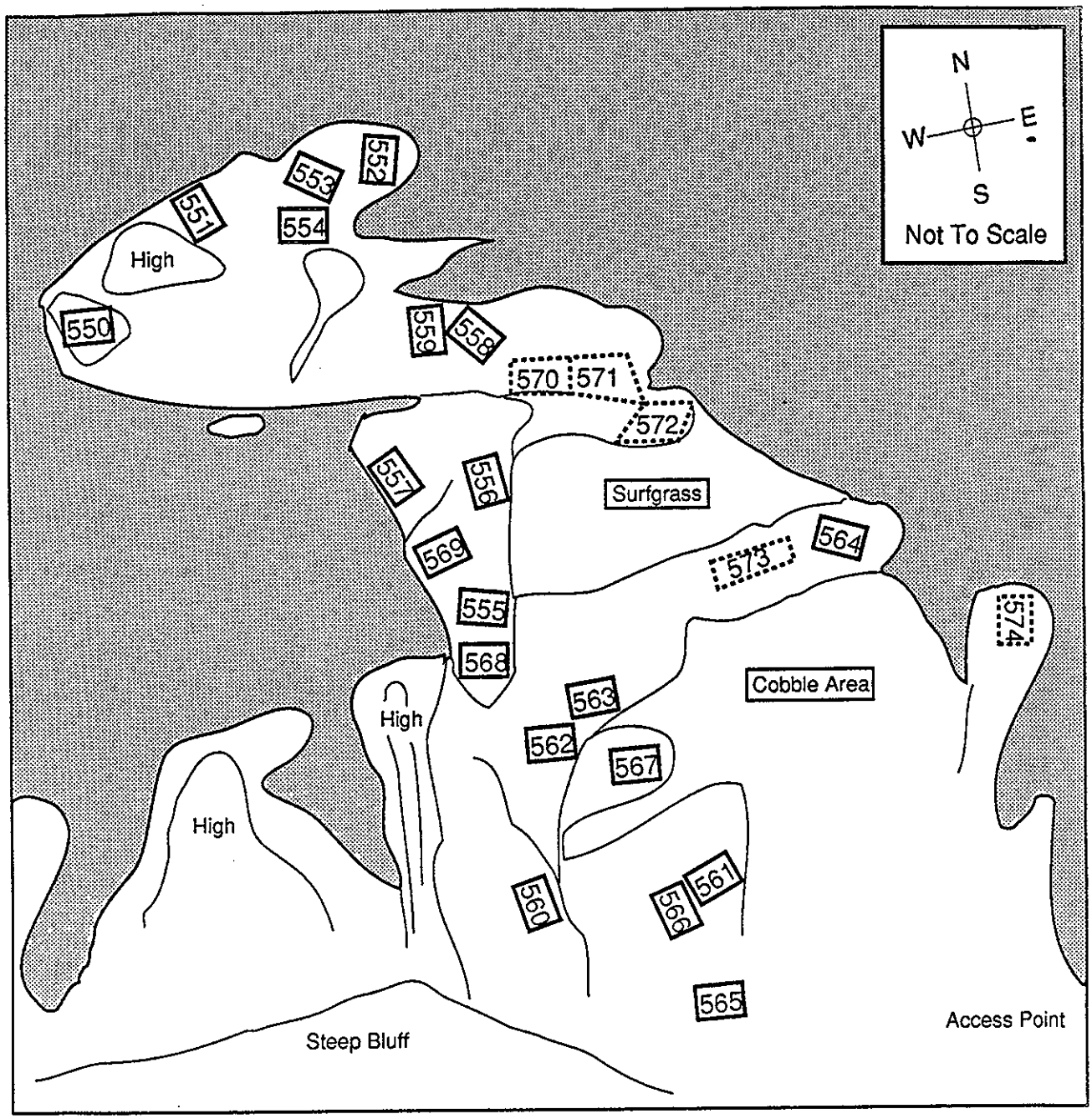
Figure A - 13. SANTA ROSA ISLAND
Fossil Reef
Intertidal Monitoring Site
Established March 1988



QUADRAT NUMBERS

Barnacles	500 - 504
Endocladia	505 - 509
Mussel	510 - 514
Abalone Plots	515 - 519
Lottia	595 - 599
	One Bolt Only

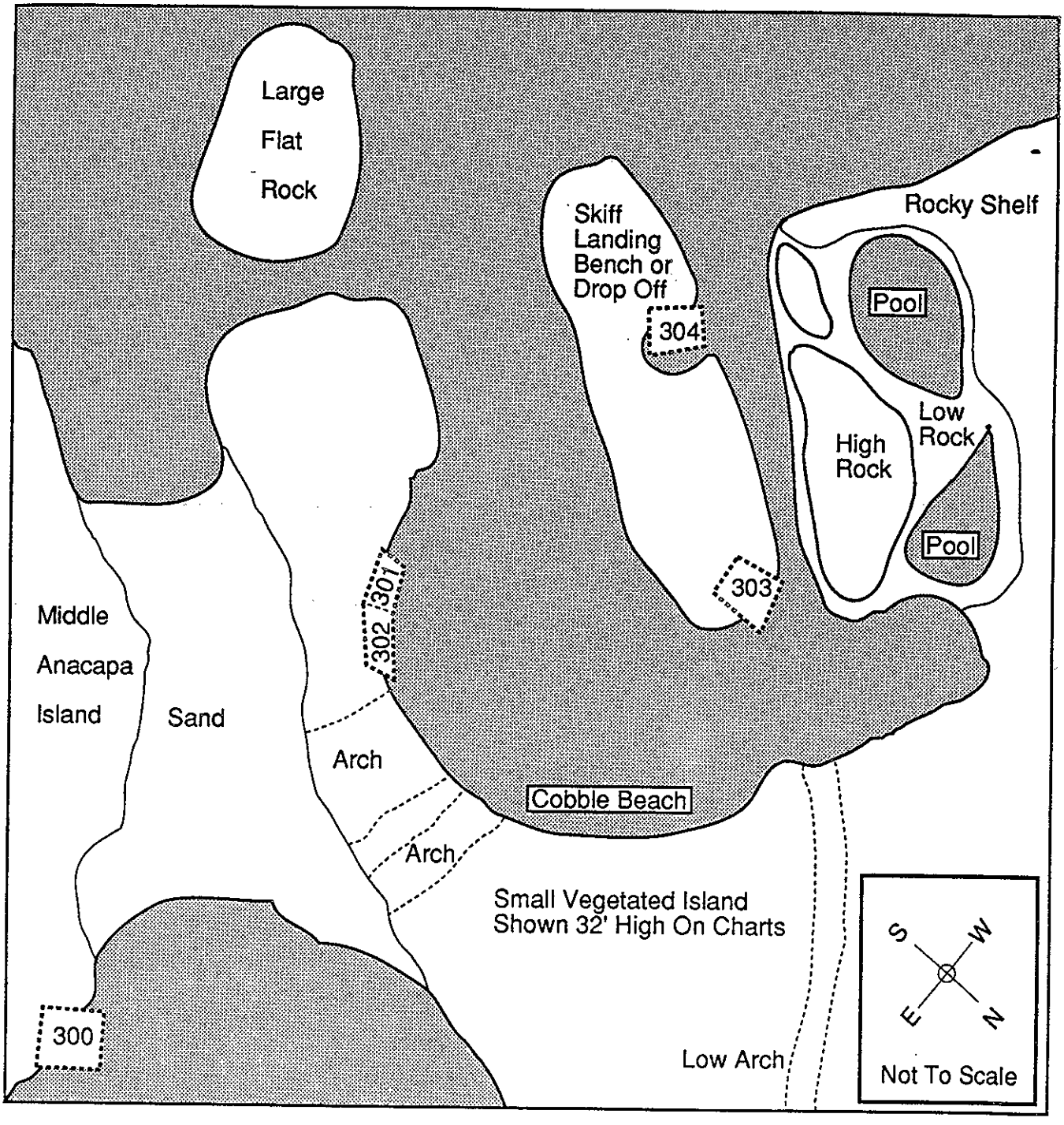
Figure A - 14. SANTA ROSA ISLAND
Johnson's Lee
Intertidal Monitoring Site
Established December 1985



QUADRAT NUMBERS

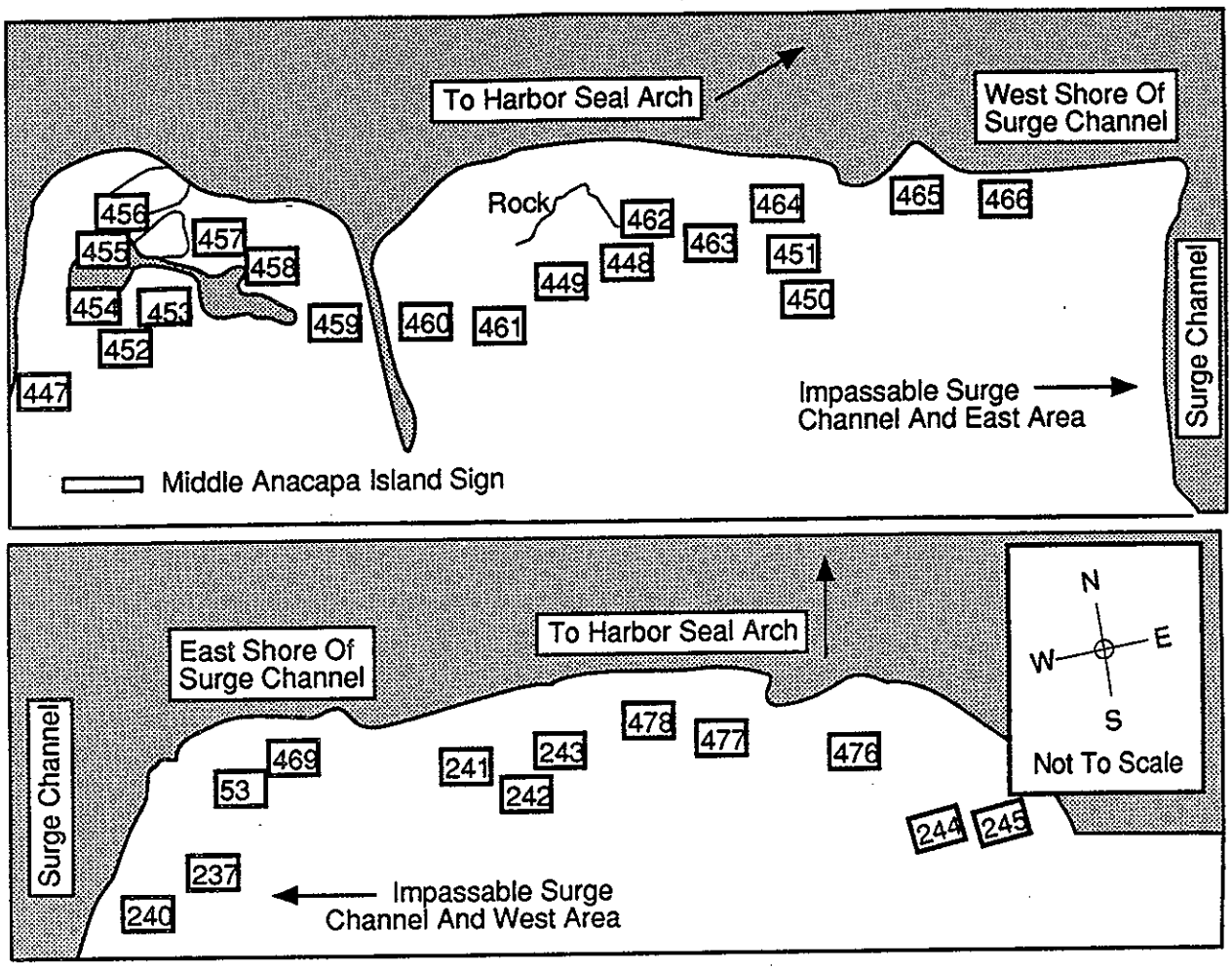
Barnacle	560 - 564
Endocladia	555 - 559
Mytilus	550 - 554
Rockweed	565 - 569
Abalone Plots	570 - 574

Figure A - 15. SANTA ROSA ISLAND
Northwest Talcott
Intertidal Monitoring Site
Established November 1986



Abalone Plots 300 - 304

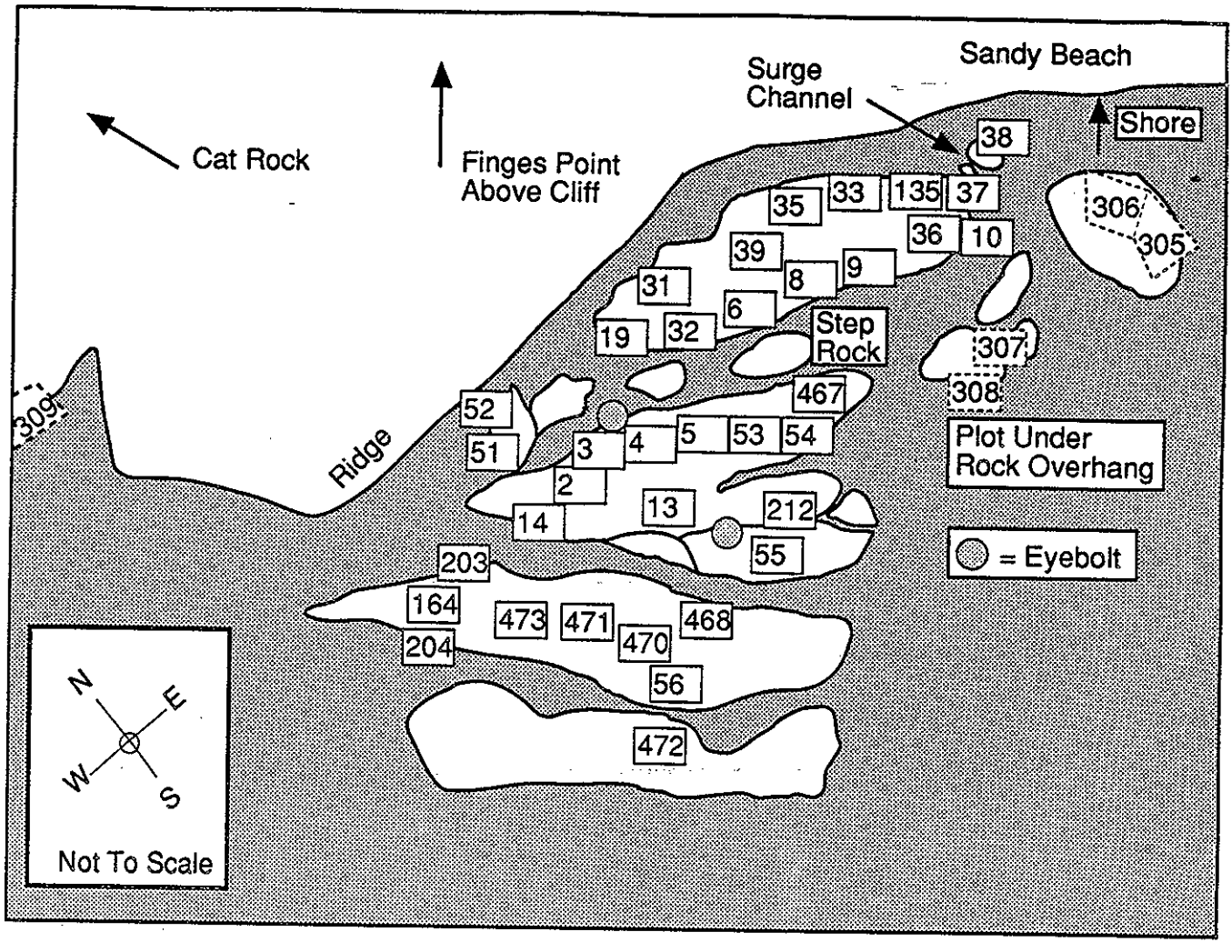
Figure A - 16. ANACAPA ISLAND
Harbor Seal Arch
Intertidal Monitoring Site
Established March 1985



QUADRAT NUMBERS **Figure A - 17.** MIDDLE ANACAPA ISLAND West and East Intertidal Monitoring Sites

Established 1982

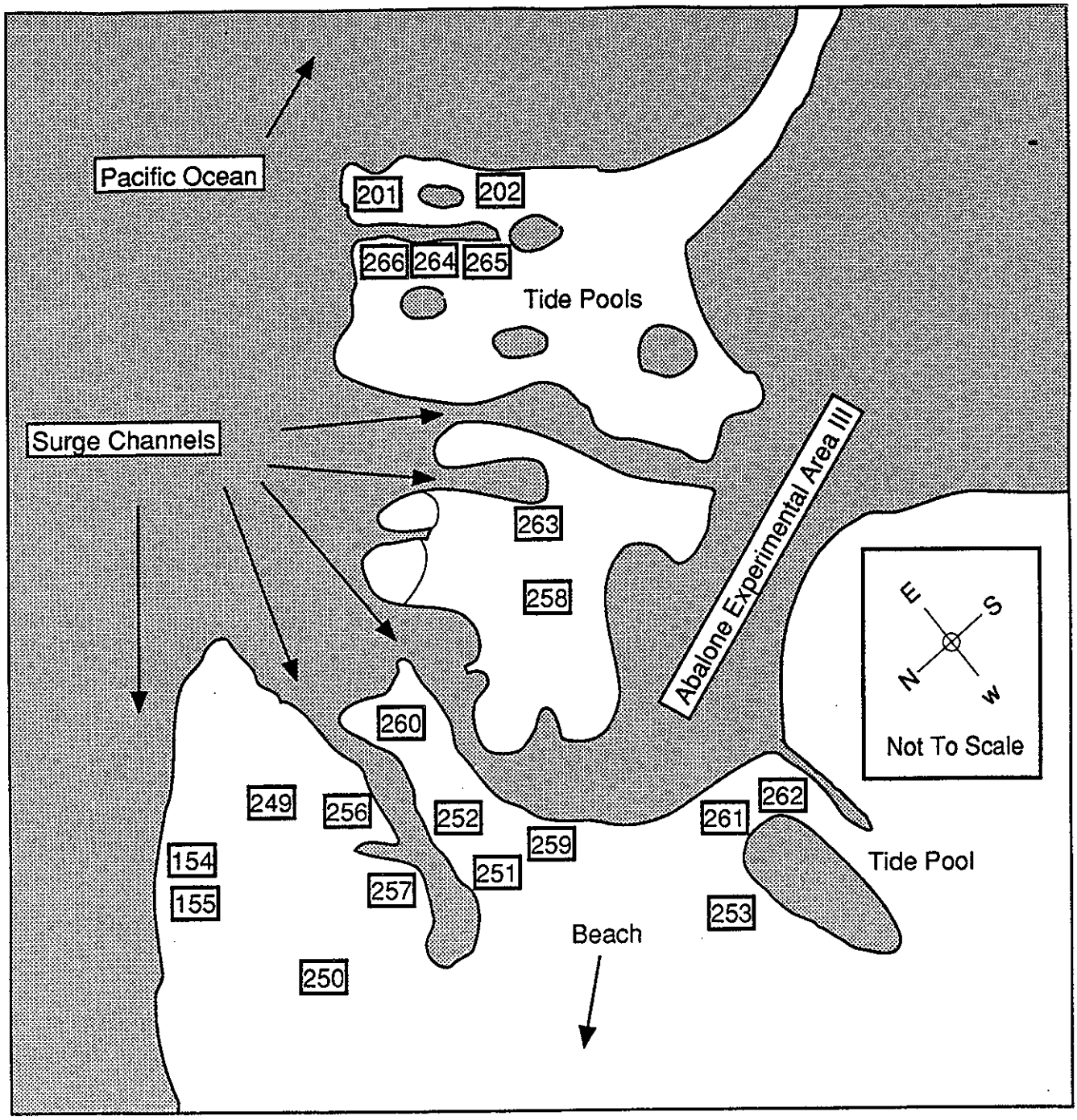
Barnacle	243 - 245, 447 - 451
Endocladia	240 - 242, 457 - 461
Mussel	476 - 478, 462 - 466
Rockweed	53, 237, 469, 452 - 456,



QUADRAT NUMBERS

Barnacle	31 - 33, 35 - 39, 135
Endocladia	13, 14, 19
Mussel	51 - 54, 212, 467 56, 164, 203, 204, 468, 470 - 473
Rockweed	2 - 6, 8 - 10, 55
Abalone Plots	305 - 309

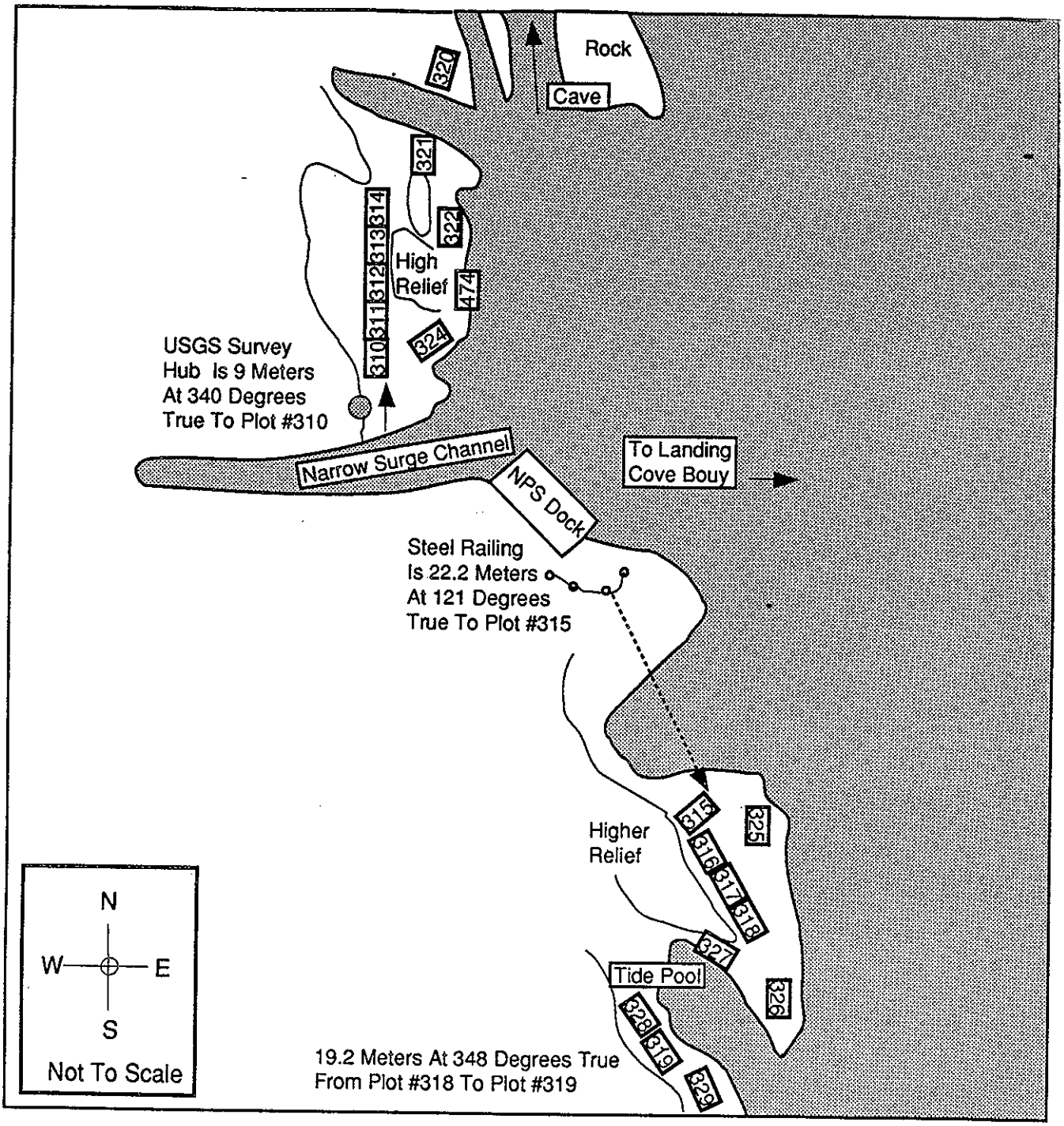
Figure A - 18. WEST ANACAPA ISLAND
Cat Rock
Intertidal Monitoring Site
Established 1982



QUADRAT NUMBERS

Barnacle	249 - 253
Endocladia	254 - 258
Mussel	201 - 202, 264 - 266
Rockweed	259 - 263

Figure A - 19. WEST ANACAPA ISLAND
Frenchy's Cove
Intertidal Monitoring Site
Established 1982

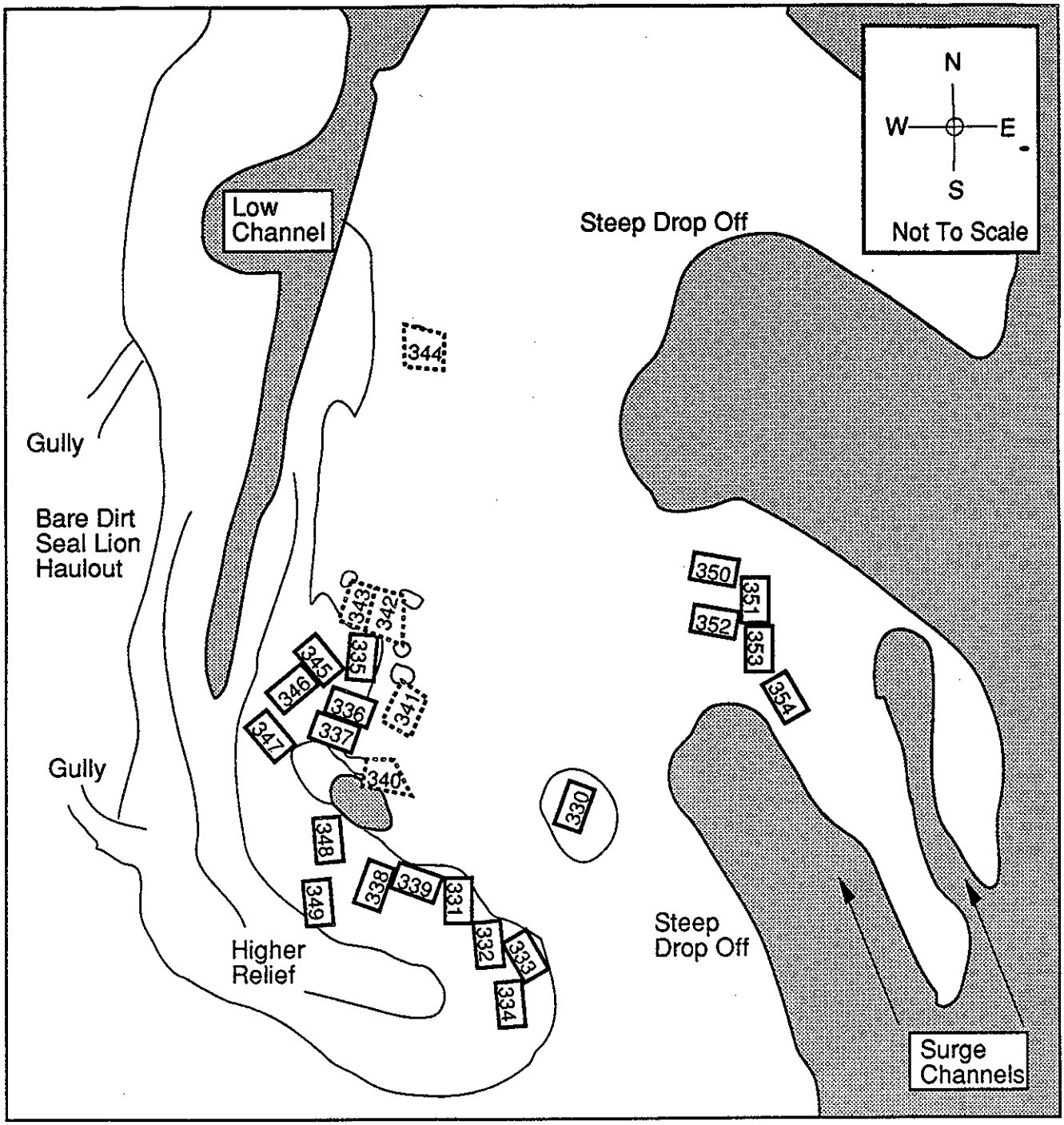


QUADRAT NUMBERS

Barnacle	315 - 319
Mussel	325 - 329
Red Algal Turf	320 - 322, 324, 474
Rockweed	310 - 314
	Bolts in upper right corner

Figure A - 20. SANTA BARBARA ISLAND
East and West Landing Cove
Intertidal Monitoring Site

Established March 1985



QUADRAT NUMBERS

Barnacle	345 - 349
Endocladia	335 - 339
Mussel	350 - 354
Rockweed	330 - 334
Abalone Plots	340 - 344

Figure A - 21. SANTA BARBARA ISLAND
Sea Lion Rookery
Intertidal Monitoring Site

Established March 1985

SUMMARY OF MONITORING LOCATIONS

Island	Site Name	Site Abreviation	Quadrat Data[1] Location Code	Abalone Data[1] Location Code
San Miguel	Crook Point	SMICP	7	7
	Cuyler Harbor	SMICH	15	
	Harris Point	SMIHP	6	6
	Otter Harbor	SMIOH	8	8
Santa Rosa	East Point	SRIEP	9	9
	Ford Point	SRIFP	2	2
	Fossil Reef	SRIFR	16	
	Johnson's Lee	SRIJL	3	3
	Northwest Talcott	SRINW	10	10
West Anacapa	Cat Rock	WAICR	4	4
	Frenchy's Cove	WAIFC	12	
Mid. Anacapa	East	MAI East	13	
	West	MAI West	14	
	Harbor Seal Arch	MAIHSA	5	5
Santa Barbara	Landing Cove	SBILC	11	
	Sea Lion Rookery	SBISLR	1	1

[1] Codes for computer data analysis (see Appendix D)

APPENDIX B. Data Sheets

ROCKY INTERTIDAL STUDY SITE MAP

DATA SHEET #1 Date _____ Page #_____

Island _____ Study Site _____

Recorder_____

MAP*

* Sketch of study site, including quadrat locations and natural landmarks

ROCKY INTERTIDAL ABALONE PLOT LOCATION DATA

DATA SHEET #2A Date_______________ Page #______________________

Island ________________________________ Study Site _____________________________

Recorder______________________________

From Plot #	To Plot #	Distance (meters)	Inner Corner Angles (degrees)

From Plot #	To Plot #	Distance (meters)	Inner Corner Angles (degrees)

ROCKY INTERTIDAL PHOTOQUADRAT LOCATION DATA

DATA SHEET #2B Date__________ Page #__________

Island __________ Study Site __________

Recorder__________

From Quadrat #	To Quadrat #	Distance (meters)	True Compass Heading (degrees)	From Quadrat #	To Quadrat #	Distance (meters)	True Compass Heading (degrees)

ROCKY INTERTIDAL QUADRAT DESCRIPTION LOG

DATA SHEET #3 Date _____ Page # _____

Island _____ Study Site _____

Recorder _____

Quadrat #	Key Species	Quadrat Description*

* Relative abundance of major species, field notes, observations, etc.

ROCKY INTERTIDAL PHOTODATA LOG

DATA SHEET #4A Date _____ Page # _____

Island _____ Film Roll # _____

Photographer _____ Recorder _____

Photo #	Study Site	Quadrat #	Shutter F-Stop	Film Speed	Comments
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					
16					
17					
18					
19					
20					

EXAMPLE

ROCKY INTERTIDAL PHOTODATA LOG

DATA SHEET #4B Date _____ Page #_____

Island _____ Film Roll # _____

Photographer _____ Recorder _____

Photo #	Study Site	Quadrat #	Shutter F-Stop	Film Speed	Comments
21					
22					
23					
24					
25					
26					
27					
28					
29					
30					
31					
32					
33					
34					
35					
36					
37					
38					
39					
40					

EXAMPLE

ROCKY INTERTIDAL BLACK ABALONE DENSITY

DATA SHEET #5 Date _____ Page # _____

Island _____ Study Site _____

Recorder _____

Quadrat #	Abalone #	Length (mm)	Quadrat #	Abalone #	Length (mm)	Quadrat #	Abalone #	Length (mm)

EXAMPLE

ROCKY INTERTIDAL FIELD LOG

DATA SHEET #6 Date _____ Time _____ Page #_____

Island _____ Study Site _____
Weather Description _____ Recorder _____
Temp (___C) Air _____Water _____ Tide Level (ft.) _____
Wind: Speed (kt.) _____ Direction _____ Cloud Cover (____%)
Wave Height (ft.) _____ Surge (light, moderate, heavy) _____

Field Log (General account of intertidal work, including observations and sketches):

DATA SHEET #7 ROCKY INTERTIDAL PHOTOQUADRAT DATA

Raw Data - Station _____ Date _____

Date Scored _____

BARNACLE ZONE

Quadrat Number						
Total Ponits						
Bare Rock						
Acorn Barnacle						
Endocladia						
Pelvetia						
Mytilus						
Red Algal Turf						
Misc. Algae						
Misc. Animals						
Tar						
Other						

ENDOCLADIA ZONE

Quadrat Number						
Total Ponits						
Bare Rock						
Acorn Barnacle						
Endocladia						
Pelvetia						
Mytilus						
Red Algal Turf						
Misc. Algae						
Misc. Animals						
Tar						
Other						

EXAMPLE

PELVETIA ZONE

Quadrat Number						
Total Ponits						
Bare Rock						
Acorn Barnacle						
Endocladia						
Pelvetia						
Mytilus						
Red Algal Turf						
Misc. Algae						
Misc. Animals						
Tar						
Other						

MYTILUS ZONE

Quadrat Number						
Total Ponits						
Bare Rock						
Acorn Barnacle						
Endocladia						
Pelvetia						
Mytilus						
Red Algal Turf						
Misc. Algae						
Misc. Animals						
Tar						
Other						